This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

HE
4491
S825S8

UC-NRLF
$B 100 345

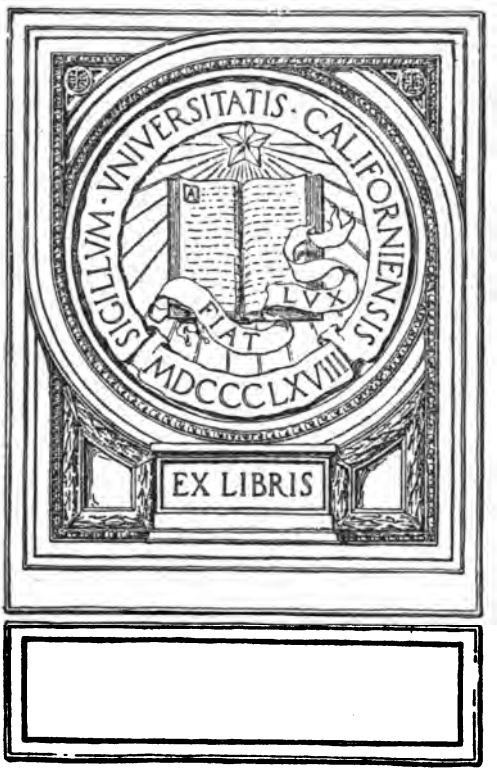
TRAFFIC AND OPERATION

SPRINGFIELD STREET RAILWAY COMPANY

SPRINGFIELD
MASSACHUSETTS

ALBERT S. RICHEY
ELECTRIC RAILWAY ENGINEER
WORCESTER, MASSACHUSETTS

APRIL, 1917


SIGILLVM · VNIVERSITATIS · CALIFORNIENSIS
LVX
FIAT
MDCCCLXVIII
EX LIBRIS

TRAFFIC AND OPERATION

SPRINGFIELD STREET RAILWAY COMPANY

SPRINGFIELD, MASSACHUSETTS

UNIV. OF CALIFORNIA

ALBERT S. RICHEY
ELECTRIC RAILWAY ENGINEER
WORCESTER, MASSACHUSETTS

APRIL, 1917

HE 4491
S 825 S8

UNIV. OF
CALIFORNIA

97 C

CONTENTS

Letter of Transmittal	1
Territory Served, Map, with distribution of population	4
Description of territory served, five cent fare zone compared with other cities	5
Maps of single fare zones, various cities	6, 7, 8
Comparative data on single fare zones, various cities	10
General statistical data	12
Description of form of chart used in presenting various operating data	16
Operating Revenue per Car Hour	17
Operating Revenue per Car Mile	18
Operating Expense per Car Hour	19
Operating Expense per Car Mile	20
Operating Expense—Operating Revenue	21
Net Revenue Less Taxes per Car Mile	22
Car Miles per Car Hour	23
Maintenance of Equipment per Car Mile	24
Kilowatt hours per Car Mile	25
Wages of Conductors and Motormen	26
Traffic Survey, Description of	29
Description of charts used in presenting traffic data	33
Frequency of service or maximum load charts	33
Characteristic or route load curves	35
Monthly variation charts	38
Daily variation charts	39
Transfer data	41
Service standards	42
Data on closed cars	44
Loading time, various types of cars	47
General data from traffic survey	49
Adequacy of present service	49
Average ride per passenger	50
Car flow diagram, downtown district	52
Details of survey by routes	53
Maple St.—Brightwood, No. 1	53
Crosstown—Walnut St. and Forest Park, No. 2	55
King—Chestnut Sts., No. 3	56
Wason Ave.—East Springfield, No. 4	57
Hancock St.—Feeding Hills, No. 5	60
Wilbraham Rd.—Brightwood, No. 6	61
Catherine—Worthington Sts., No. 7	61
State St.—West Springfield, No. 8	62
Indian Orchard and Ludlow, No. 9	63

R
464985

Springfield—Palmer, No. 10 64
Belmont Ave.—Brightwood, No. 13 65
Dickinson St.—Brightwood, No. 14 65
Forest Park—Chicopee Falls, No. 15 65
Plainfield St.—Forest Park, No. 16 66
East Longmeadow—Mittineague, No. 17 67
Springfield—Longmeadow, No. 19 68
Springfield—Chicopee via Glenwood, No. 22 68
Springfield—Chicopee Falls via Liberty St., No. 23 69
Springfield—Holyoke, No. 24 70
Springfield—Westfield, No. 25 70
Springfield, Agawam and Hartford West Side, No. 26.... 71
Belmont Ave., one-way operation 71
Chestnut and Carew Sts., one-way operation 72
Transfer system, suggested changes 73
White Pole Stopping Places 77
Main Street, vehicular traffic 79
Jitney problem 81
Main Street, operation of cars 83
Present delays 84
Possible reduction in number of cars 85
Possible reduction in time for loading and unloading—
Multiple berth stops 86
More rapid acceleration and braking 87
Improved traffic regulation 88
Other unnecessary delays, Carew Street 90
Regular Schedules 91
Improvements in Road and Equipment 93
Improvements completed since 1913 92
Improvements authorized, not yet completed 94
Hooker St. car house 93
Carew St. shops 93
Three-wire distribution system 95
New power contract 96
Cost of proposed extensions 97
Paying Haul in Springfield 101
Wisconsin method 102
Massachusetts method 107
Comparison 108, 109
Increased revenue needed 110

UNIV. OF CALIFORNIA

ALBERT S. RICHEY
ELECTRIC RAILWAY ENGINEER
WORCESTER, MASSACHUSETTS

APRIL 30, 1917.

MR. C. V. WOOD, PRESIDENT,
Springfield Street Railway Company,
Springfield, Massachusetts.

DEAR SIR:—About January 1 you authorized me to make a traffic survey and general report on street railway operation in the Springfield (first fare zone) district as served by your Company.

After the necessary preparation, including the numbering of all white pole stops and the training of the required force of traffic inspectors, the traffic survey was begun on January 22 and completed on February 13. During this period your Auditing Department was collecting and tabulating such information as had been requested of it. The principal data derived from the traffic survey proper is included in the form of charts which are bound separately as a supplement to this report.

The report, which is handed to you herewith, includes a discussion of the relative magnitude of the various expenditures of your Company, the fiscal years 1911 to 1916 being compared, and, wherever possible, comparisons being made between these and corresponding figures for other street railways in the state.

A description of the methods used in making and analyzing the traffic survey is included, together with a detailed study of the results of operation of the various routes.

A study of the present congested district along Main Street is included, with an analysis of the various factors contributing to such congestion, and suggestions for its relief. Suggestions are made also relative to a change in the transfer system, the spacing of white pole stopping places, re-routeing of certain lines, construction of additional track, and increases and decreases in headway of cars.

UNIVERSITY OF CALIFORNIA

Analyses of the cost of the service rendered are shown, with calculations as to the length of paying haul, or maximum length of profitable ride. Such studies have been made by two different methods, one, that used by the Wisconsin Commission, and the other by the Massachusetts Commission; in each case, these have been based on various assumptions as to the return on investment, etc. Such studies show the length of paying haul to approximate 2¼ miles, while the average length of ride, as shown by the traffic survey, is more than 2¾ miles.

Statements are included showing the estimated cost of extensions proposed, together with others showing improvements and extensions made during the last three years and others in process of making, but not completed, with estimates of costs.

The general statistical data shown in the first 28 pages of the report apply to the entire company. In the remainder of the report, the figures used apply only to the Springfield Division (first five-cent fare zone), unless otherwise noted. Data used as from the traffic survey, including calculations of load factor, average ride per passenger, and paying haul, together with estimates of new money required, apply only to the Springfield Division (first five-cent fare zone).

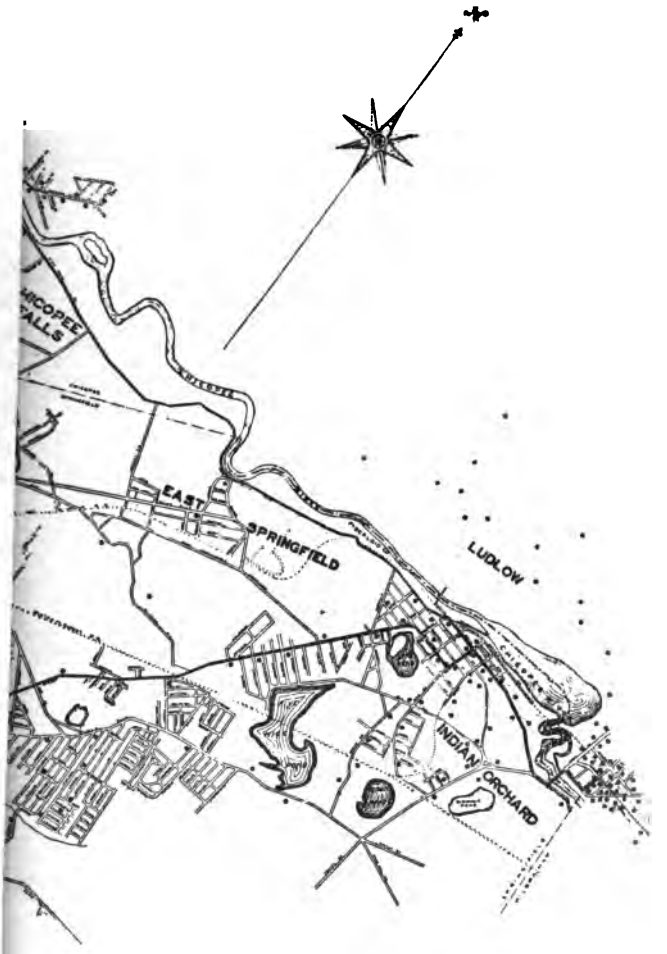
It should be clearly understood that all of the recommendations made herein, which involve the expenditure of a considerable amount of money, cannot be carried out unless some form of relief in the way of either increased income or reduced expenditures can be had. Although some help may be had along the lines of reduced expenditures, as suggested in the report, it will be necessary to increase the revenue in some manner, in order to fully justify the capital expenditures which are recommended. Some such increase may come as the result of improved service, some may come as the result of a better system of transferring passengers, and the remainder must come in the form of some sort of increased fare. If possible, this should be worked out so that it will put the added burden where it properly belongs, *i. e.,* on the long distance riders in the present five-cent fare zone, such as those to and from the Chicopees, Indian Orchard, the Longmeadows, Agawam and Feeding Hills. I am not yet prepared to express an opinion as to whether this should be done by drawing in the boundaries of the five-cent fare zone limit, with an additional two or three-cent fare to

those passengers riding beyond such new limits, or by leaving the base fare as five cents, but limiting such fare to a ride between the outer ends of these long lines and the center of the city and making a charge for such transfers as may be used to and from them, limiting the free transfer to those short haul passengers who both board and alight within a central free transfer area. One of these plans, or suitable modification, could be worked out by a further study of the detailed characteristics of the individual routes in such a manner as to be equitable to each class of your patrons.

Any zone system of fare collection, as suggested above, will involve many difficulties in the proper collection of fares and use of transfers, and on account of these difficulties, such a zone system may be considered impracticable. In such case, the increase in revenue should be had by a flat increase to a universal six-cent fare. It may be advisable to adopt this latter plan for immediate relief, while further studies of the details of the zone system, including methods of fare collection, are being made.

Respectfully submitted,

Albert S. Richey



SPRINGFIELD & VICINITY

SHOWING STREET RAILWAY LINES AND DISTRIBUTION OF POPULATION

SCALE OF MILES

517-1

TERRITORY SERVED BY THE SPRINGFIELD DIVISION SPRINGFIELD STREET RAILWAY COMPANY

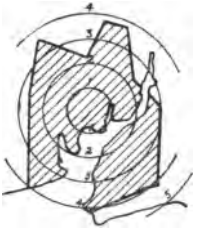
Comparison of the Springfield Five-Cent Fare Zone With Other Cities

The territory served by the Springfield division of the Springfield Street Railway Company comprises the entire area of the city of Springfield and the town of West Springfield, together with that portion of Chicopee which lies south of the Chicopee River, and also portions of Ludlow, East Longmeadow, Longmeadow, Agawam and Mittineague. This territory is shown by the insert map opposite, which also indicates the trackage of the railway company, and further, the approximate distribution of the population served. Each of the small black dots approximately represents the center of a population of 100. The net population per square mile of area served in this five-cent fare zone is small, due, first, to the large sparsely settled areas between Springfield proper and Chicopee, Chicopee Falls and Indian Orchard, and second, to the large sparsely settled areas reached by the long outlying lines to East Longmeadow, Longmeadow, Agawam, Feeding Hills, Tatham and Holyoke.

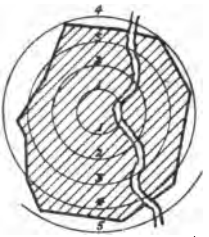
For the purpose of comparison, outline maps of the single fare zones of thirty cities, including Springfield, have been drawn and are reproduced on the following pages, all to the same scale of approximately one-eighth inch to the mile. On each of these small maps, mile circles have been drawn, showing the distance from the traffic center or principal transfer point.

The shaded area of each map shows roughly the area served by the five-cent fare zone of the street railway. The outline is not that of the territorial area of the city, but is formed by joining the outlying ends of the various street railway lines, or the ends of the first five-cent fare limits where lines extend beyond. In the case of cities which are located on the banks of an ocean, lake or large river, the approximate contour of the water front is shown as limiting the area on that side, except where the five-cent fare zone extends to the opposite side of a river.

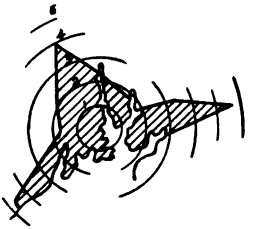
Eighteen of the cities shown are located in New England, the others being typical cities of a larger population than Springfield, and located west of the Hudson River.



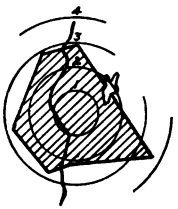
NEW HAVEN



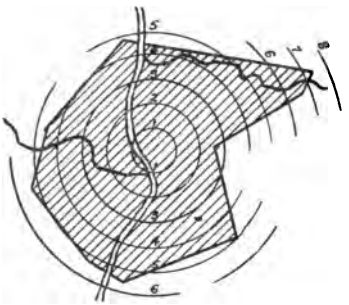
HARTFORD



BRIDGEPORT

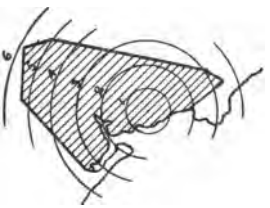


WATERBURY

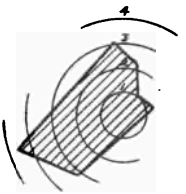


SPRINGFIELD

BROCKTON

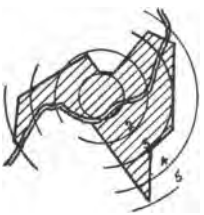


LYNN

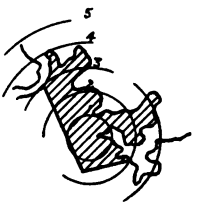


TAUNTON

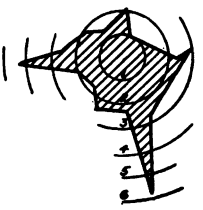
FALL RIVER



LAWRENCE



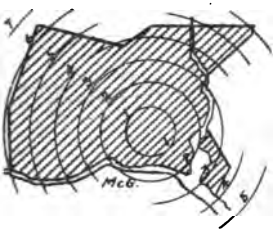
QUINCY



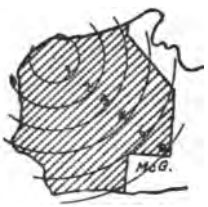
LOWELL

517-2A

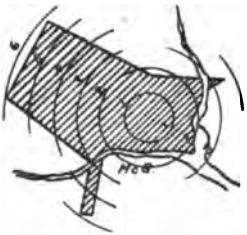
Comparative Areas of Five-Cent Fare Zones



WASHINGTON
Wash. Ry. & El. Co.

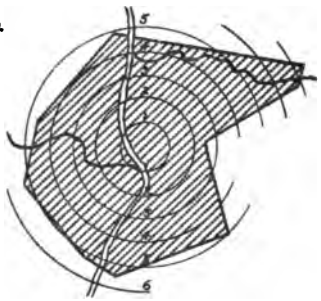


SAN FRANCISCO



WASHINGTON
Capitol Traction Co.

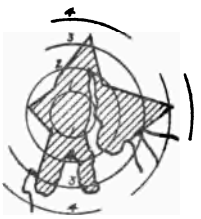
PORTLAND, ME.



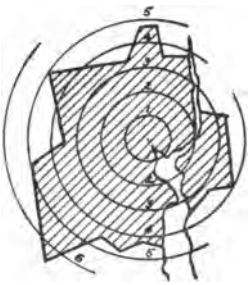
SPRINGFIELD

MANCHESTER

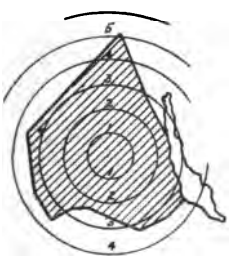
HOLYOKE



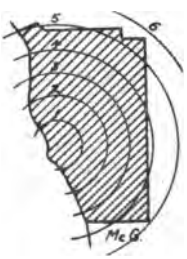
NEW BEDFORD



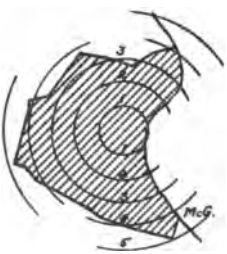
PROVIDENCE



WORCESTER



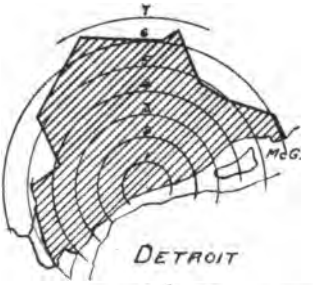
BUFFALO



MILWAUKEE

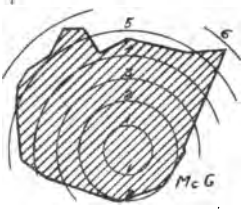
517-2B

Comparative Areas of Five-Cent Fare Zones

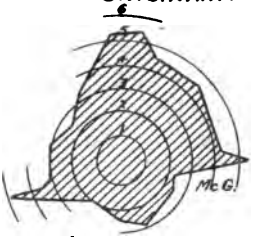


DETROIT

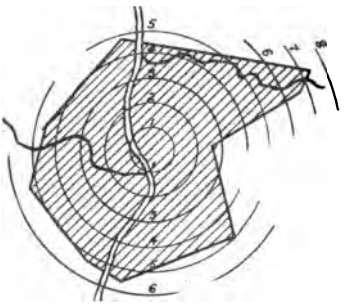
CINCINNATI



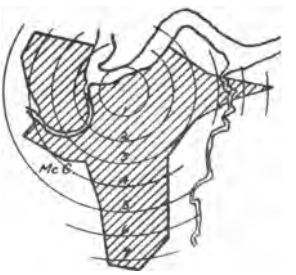
BALTIMORE



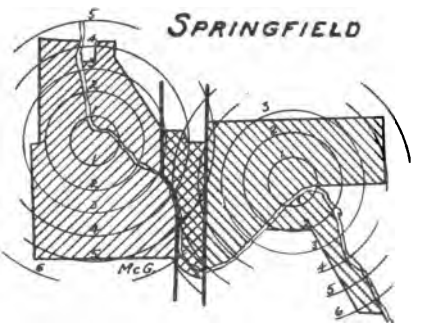
INDIANAPOLIS



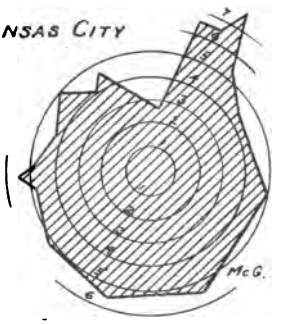
SPRINGFIELD



KANSAS CITY



MINNEAPOLIS ST. PAUL



LOS ANGELES

517-2C

Comparative Areas of Five-Cent Fare Zones

The table which is shown on page 10 gives the population of these cities for 1915, these figures being that of the state census, when available, otherwise, the estimate of the U. S. Census Bureau.

The figures shown under the heading "Area, Sq. Miles" are not those of the actual territorial area of the political division, but the area of the five-cent fare zone as shown on the small maps and as described above. In some few cases, such as Springfield, this includes some area beyond the actual city limits, but in no other case is so large a proportion of the area outside of the city limits. In some cases, the five-cent fare zone is considerably smaller than the area included within the city limits.

The figures shown under the heading "Average Radius, Mi." were calculated arithmetically from the diagrams shown and roughly indicate the average distance from the traffic center to the limits of the five-cent zone. Where the traffic center is located close to one side of the five-cent area, such as in Lynn, Bridgeport, Buffalo, San Francisco and others, due allowance has been made for this in calculating the average radius.

The last column of the table, headed "Relative Density of Population," shows for each case the figure obtained by dividing the population shown by the area as shown in the second column. Such area is not coincident with the area to which the population figures apply, and therefore is not the exact population per square mile in the majority of the cases. It is a figure, however, that indicates fairly well the relative population density as between the thirty cities.

These maps of single fare zones and the accompanying table are of interest in connection with the study of the Springfield traffic problem, as they bring out the long average maximum possible ride in Springfield, here shown as 4.6, as compared with the maximum of 3.9 in any other New England city shown, this service being rendered in Springfield in an area of 66 square miles, as compared with the maximum of 48 in any other New England city shown. The Springfield population density, which may be expressed by the figure 2190, is smaller than any of the other New England cities shown except Holyoke, being considerably less than one-half that of nearly all of the others.

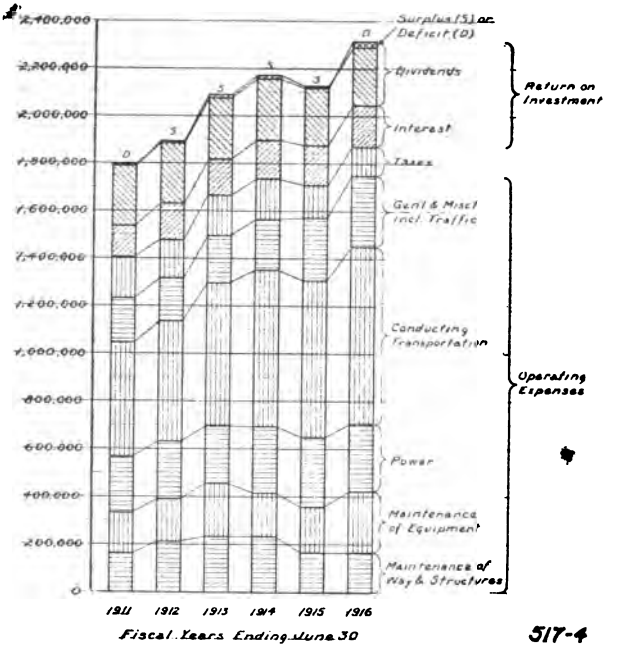
Population, Area and Average Radius of Single Fare Zone Various Cities

City	1915 Population	Area, Sq. Miles	Average Radius, Mi.	Relative Density of Population
Taunton	36,161	13	2.4	2780
Quincy	40,674	9	1.8	4520
Holyoke	60,816	43	3.7	1410
Brockton	62,288	22	2.6	2830
Portland, Me.	63,014	18	2.4	3500
Manchester, N. H.	76,959	12	1.9	6410
Waterbury	84,745	19	2.5	4460
Lawrence	90,259	22	2.7	4100
Lynn	95,803	23	3.0	4160
Lowell	107,978	15	2.2	7200
Hartford	108,969	42	3.7	2600
New Bedford	109,568	13	2.1	8430
Bridgeport	118,434	15	2.4	7900
Fall River	124,791	12	2.2	10390
SPRINGFIELD	*144,448	66	4.6	2190
New Haven	147,095	23	3.0	6400
Worcester	162,697	34	3.3	4790
St. Paul	241,999	50	4.0	4840
Providence	247,660	48	3.9	5150
Indianapolis	265,578	36	3.4	7380
Kansas City, Mo.	289,879	51	4.9	5690
Minneapolis	353,460	61	4.4	5790
Washington (a)	358,679	48	4.6	7475
Washington (b)	358,679	29	3.5	
Cincinnati	406,706	58	5.9	7000
Milwaukee	428,062	33	3.6	12970
San Francisco	456,009	40	5.5	11400
Buffalo	461,335	38	4.8	12100
Los Angeles	475,367	72	4.8	6600
Detroit	554,717	58	5.5	9560
Baltimore	584,605	50	4.0	11670

* Includes Chicopee and West Springfield
(a) Washington Railway & Electric Co.
(b) Capital Traction Company

The comparison with twelve cities outside of New England, ranging in population from 242,000 to 585,000, shows only one with a larger area in the five-cent zone than Springfield, only six with a longer average radius of the five-cent zone from the traffic center and all having a very much greater density of population.

Information as to single fare zones used above was in most cases obtained as first-hand information from the individual cities. In the case of those maps marked with the letters "McG," however, the information was taken from a paper by Mr. D. J. McGrath (Electric Railway Journal, August 5, 1916).



GENERAL STATISTICAL DATA

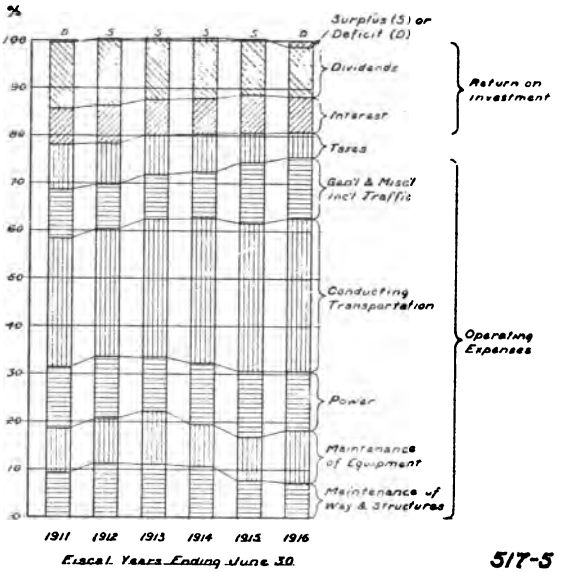
Chart No. 517-4, above, shows the expenditures of the Springfield Street Railway Company for the fiscal years ending June 30, 1911 to 1916, inclusive, divided into the main operating accounts.

Chart No. 517-5 on page 13 shows this same information expressed, however, as a per cent distribution of the total expenditures.

In general these charts bring out the following facts:

The total expenditures (and receipts) have increased from about $1,800,000 in 1911 to $2,300,000 in 1916, this increase being gradual and constant except that the amount for 1915 is less than that for 1914.

The difference between expenditures and receipts is shown by the small section at the top of each column marked "S" (surplus), when the receipts exceed the expenditures, as in the years 1912 to 1915, inclusive, and "D" (deficit), when the expendi-



tures exceed the receipts, which occurred in the years 1911 and 1916. It will be noted that in the four years which show a surplus, it is in each case considerably under 1%, the maximum being in 1913 and amounting to 0.61% of the total expenditures. The deficit in 1911 amounted to 0.37%, and in 1916 to 1.23% of the total expenditures.

The operating expenses amounting to a little over $1,200,000, or 68.6%, in 1911, have been increasing steadily until in 1916 they amounted to about $1,750,000, or 75.5% of the total expenditures.

Maintenance of way and structures, which includes repairs to track and roadway, overhead line and buildings, has fluctuated between a minimum of $164,972 in 1911 and a maximum of $232,074 in 1914, amounting in 1916 to $165,407. Expressed as a percentage of total expenditures, this amount has fluctuated between a maximum of a little over 11.2% in 1912 to a minimum of 7.1% in 1916.

Maintenance of equipment has fluctuated between a minimum of $169,820 in 1911 and a maximum of $255,595 in 1916, the percentage value being the smallest in 1914, when it was 8.7%, and the largest in the years 1913 and 1916, when in each case it was 11%.

The total of the two maintenance accounts is at present slightly over 18%, having been at the maximum in 1913, at which time it was 22%. An allowance of 18% for maintenance may be considered good present day practice.

The amount expended for power was a minimum in 1911 at $228,833, the maximum being in 1915, when it amounted to $288,376. Expressed as a percentage, it has ranged from 11.3% in 1913 to 13.6% in 1915. The 1916 expenditure for power was $283,350, or 12.2% of the total expenditures.

The increase in the cost of conducting transportation is the most significant item of information, as shown on these charts, as it has shown a most steady increase, not only in the amount expended, but in the per cent of total expenditures, as follows:

Year	*Expense Conducting Transportation*	
	Amount	*Per Cent*
1911	$480,297	26.8
1912	502,578	26.7
1913	602,067	29.0
1914	656,807	30.4
1915	657,394	31.0
1916	748,752	32.3

During this six-year period in which the total receipts of the company increased about 28%, the expense of conducting transportation increased about 56%, and the percentage of receipts paid out for conducting transportation increased about 20%. In 1911 and 1912 less than 27c of each dollar of receipts was spent for this item, in 1916 more than 32c. This item, which is almost wholly composed of wages, is discussed in more detail at another place in this report.

The general and miscellaneous expense, as shown on Charts Nos. 517-4 and 517-5, range from a minimum of $179,764 in 1912 to $294,988 in 1916. Expressed as a percentage, the minimum is 9.4% in 1913 and the maximum is 12.7% in 1916. The average percentage is about the same as that of other roads in Massachusetts, which, excluding the Boston Elevated and the Springfield Street Railway, show an average of between 11% and 12% for general and miscellaneous expenses for the six years considered.

The item of taxes is at a maximum in 1914 of $172,769 and a minimum in 1916 of $124,073. Expressed as a percentage, the maximum is in 1911, 9.4%, and the minimum in 1916, 5.4%. The average per cent of expenditures in taxes for all Massachusetts street railways, except the Boston Elevated and the Springfield Street Railway, amounts to about 6% for the six years, 1911 to 1916.

The return on investment, consisting of the two items of interests and dividends, was $396,433 in 1911 and $443,864 in 1916. The return on investment, which amounted to 22% of the total expenditures in 1911, has decreased to 19.2% in 1916.

Charts Showing Various Operating Details, 1911-1916, Inc.

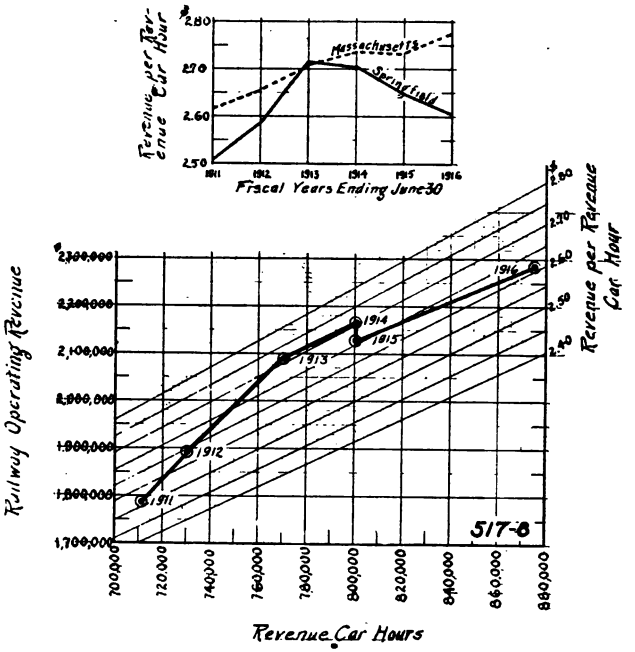
The charts on the pages immediately following show various operating data, and as a number of charts are shown, all being constructed on the same general principles, a detailed explanation will first be made of their construction.

Referring to Chart No. 517-9, page 18, "Revenue per Car Mile," it will be noted that "railway operating revenue" is represented in the vertical scale of the main chart, as per the figures on the left. "Revenue car miles" are represented in the horizontal scale, as per the figures at the bottom of the main chart. The points on the chart which are numbered and connected by a heavy black line show the performance for each individual year with respect to operating revenue and revenue car miles. For instance, referring to the point marked "1912," its height above the base line corresponds to $1,890,000, which was the operating revenue for that year. The location horizontally, corresponding to about 7,200,000, shows the number of revenue car miles operated that year. Similarly, the location of the points marked for each of the years, from 1911 to 1916, inclusive, designate both the railway operating revenue and the revenue car miles for each of the years.

Beside the two main items of railway operating revenue and revenue car miles, this chart also shows the relation between the two, which is revenue per car mile. This relation can be read for any individual year by noting the position of its point with respect to the diagonal lines, the values corresponding to which are found at the right of the chart. For instance, in 1912 the revenue per revenue car mile was about 26.2c.

On the smaller chart above the main chart will be found a plotting of the derived value (on Chart No. 517-9, "Revenue per Car Mile") for Springfield as compared for corresponding years with all of the roads in the state of Massachusetts, excluding the Boston Elevated and the Springfield Street Railway. In discussion of these charts the figures for Massachusetts, exclusive of the Boston and Springfield companies, will be referred to as the "Massachusetts" or "state" figures.

The above discussion of the construction of Chart No. 517-9 will apply to a number of other charts used herein and constructed in a similar manner, and the above discussion will be referred to in the report in lieu of describing each of the similar charts.

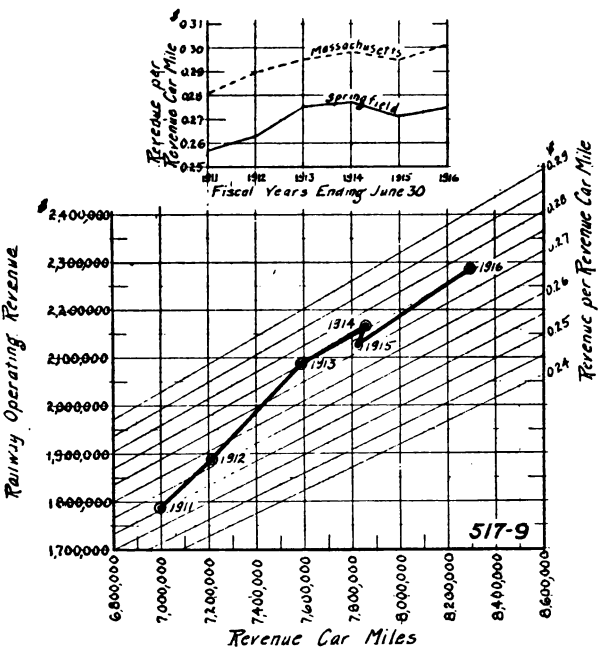


Revenue Per Car Hour

The above chart shows an increase in railway operating revenue from about $1,790,000 in 1911 to about $2,285,000 in 1916, the increase being a gradual one from year to year with the exception of a falling off in 1915. The revenue car hours have increased from about 712,000 in 1911 to about 875,000 in 1916. The revenue per car hour increased from about $2.51 in 1911 to about $2.71 in 1913, since when it has fallen off to about $2.61 in 1916. In other words, the number of car hours operated was increased at a slower rate than the revenue for the first three years considered, while for the last three years more car hours have been operated than were warranted by the increase in revenue.

The small chart, comparing with Massachusetts, shows that the state outside of Springfield has gradually and constantly increased its revenue per car hour during the six years con-

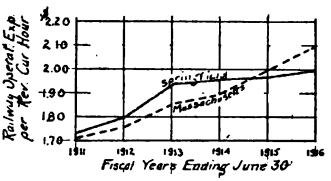
sidered; that in only one year (1913) has Springfield had as high a revenue per car hour as the rest of the state; that since that time Springfield revenue per car hour has been steadily decreasing, while that of the rest of the state has been increasing, so that in 1916 the Springfield revenue per car hour was 6% less than the rest of the state.

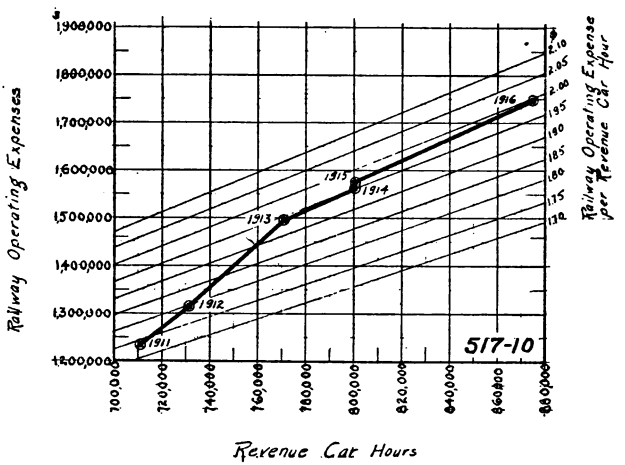


Revenue Per Car Mile

This chart is similar to the preceding one except that the railway operating revenue is compared with revenue car miles instead of car hours. This chart shows that on the Springfield system the car miles operated since 1913 have more nearly been proportional to the revenue than have the car hours, as shown by the preceding chart. Evidently, an effort has been made to adjust the car miles run to the business, and that this has been measurably successful is shown by the fact that in all of the years 1913, 1914 and 1916 the revenue per car mile is practically the same at about 27½c. That this relation is about constant, while the relation between revenue and car hours is a decreasing one, is due to the fact that the average speed has decreased, as is discussed in another place.

A comparison of Springfield with the state, as shown in the small insert chart, brings out the fact that the revenue per car mile in Springfield is from 2 to 2½ cents less than in the rest of the state throughout the whole period considered.

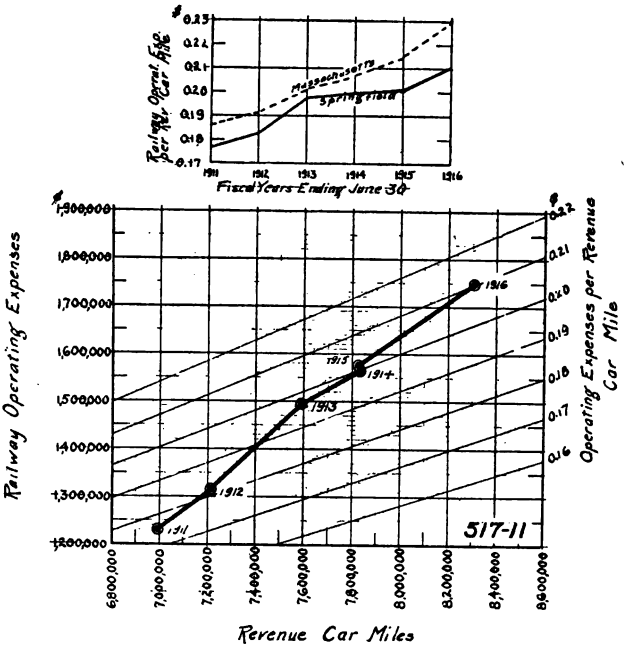




Operating Expense Per Car Hour

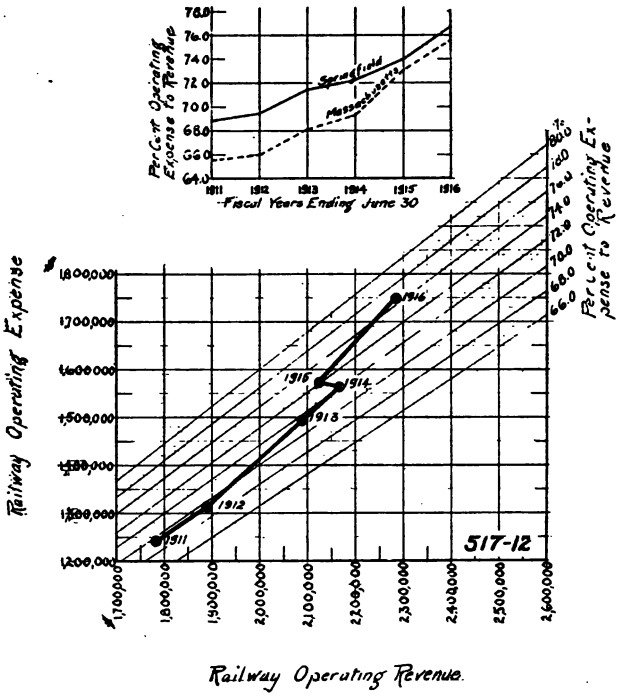
This chart shows the steadily increasing operating expenses of the railway plotted against the number of revenue car hours operated, and shows that for the past four years the operating expense per car hour has been held fairly uniform, being $1.94 in 1913 and about $2.00 in 1916.

The comparison with the state, as shown by the small insert chart, shows Springfield operating expense per car hour 2c to 8c higher than the state up until 1914, but a few cents lower than the state for the succeeding two years.



Operating Expense Per Car Mile

This chart shows the steadily increasing operating expenses as against the revenue car miles operated. It also brings out very clearly that the operating expenses are increasing at a greater rate than the car miles, the operating expense per car mile having increased from about 17.6c in 1911 to about 21c in 1916. This increase is at about the same rate as the increase in the state as a whole.

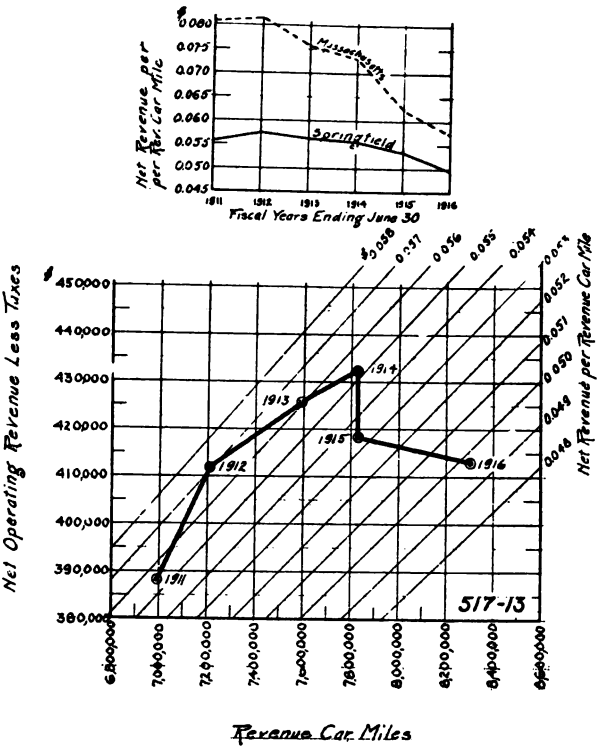


Operating Expense—Operating Revenue

This chart shows the constantly increasing railway operating expense plotted against the railway operating revenue, which also shows a gradual increase during the years noted except a falling off of something like $40,000 during the year 1915.

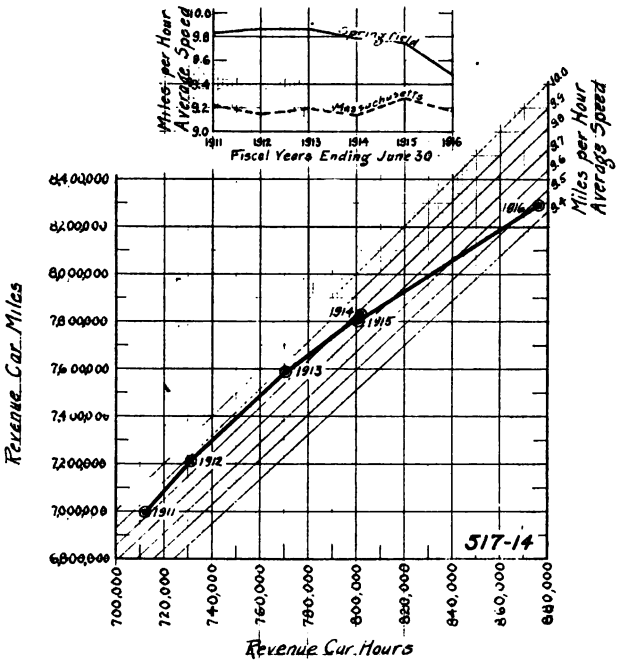
The manner in which the heavy line connecting the years' points crosses the diagonal lines shows very clearly the serious manner in which the operating expense has been increased. Expressed as a percentage of the revenue, operating expense, which was 68.8% of the revenue in 1911, has become 76.5% in 1916.

The small chart which compares with the state shows that the operating expense of the Springfield Street Railway, expressed as a per cent of the operating revenue, has constantly been higher than the railways of the rest of the state.



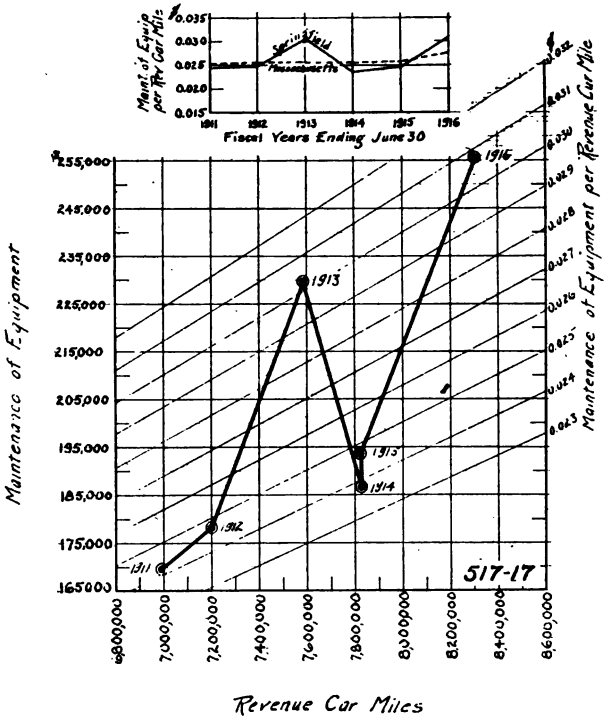
Net Operating Revenue Less Taxes Per Revenue Car Mil

The net operating revenue less taxes represents the amount available for return on investment. The above chart shows this figure plotted against the revenue car miles operated for six years, the location of the points with respect to the diagonal lines indicating the net income per car mile operated. As may be noted, the latter figure increased from about 5.55c in 1911 to about 5.70c in 1912, but since that time it has decreased steadily until the year 1916 shows less than 5c net income per car mile operated.



Car Miles Per Car Hour

The relation between revenue car miles operated and revenue car hours operated is the average speed of operation, which in miles per hour is shown by the diagonal lines on this chart. A slight increase in speed will be noted between 1911 and 1912, that of the later year being nearly 9.9 miles per hour. It has been steadily falling off since that time, however, until, in 1916, the average speed is less than 9½ miles per hour, the greatest decrease being noted between 1915 and 1916. This is due to a number of causes, as discussed elsewhere in this report. In general, it indicates less economical operation and this tendency should be corrected.



Maintenance of Equipment Per Car Mile

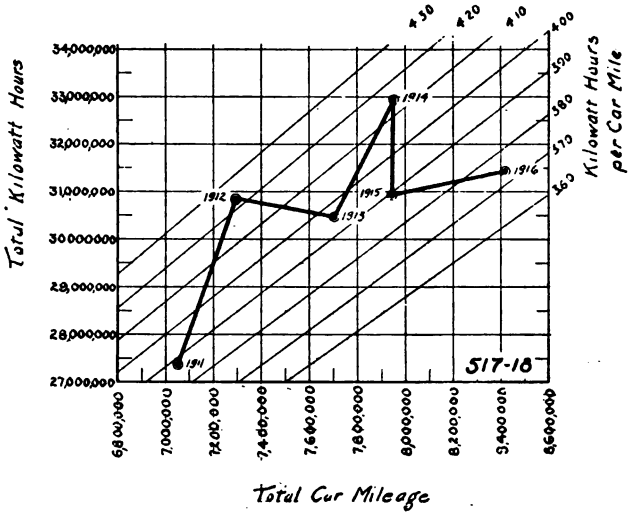
The item of maintenance of equipment includes the amounts expended for maintenance of both car and power station equipment. It will be noted that this item has fluctuated considerably since 1912, both as a total and on the basis of the amount expended on this account per car mile, the latter being shown by reference to the diagonal lines. This fluctuation has been due to the following causes:

In 1914 and 1915 the maintenance of equipment per car mile, which had been high in 1913, was materially reduced, due to the addition of a considerable amount of new car equipment. The figure was caused to again increase, however, in 1916, due to the inadequate facilities at the car house and repair shops and also due to the increasing inadequacy of the Margaret Street power station and its increasing call for maintenance.

With the inauguration of the new Hooker Street car house,

with a consequent relief of space at Carew Street (increased repair shop facilities now being installed), the item of car maintenance should again be considerably reduced within the next year. The purchase of power from an outside source, which is discussed later, will of course practically eliminate the charge of maintenance of power plant equipment.

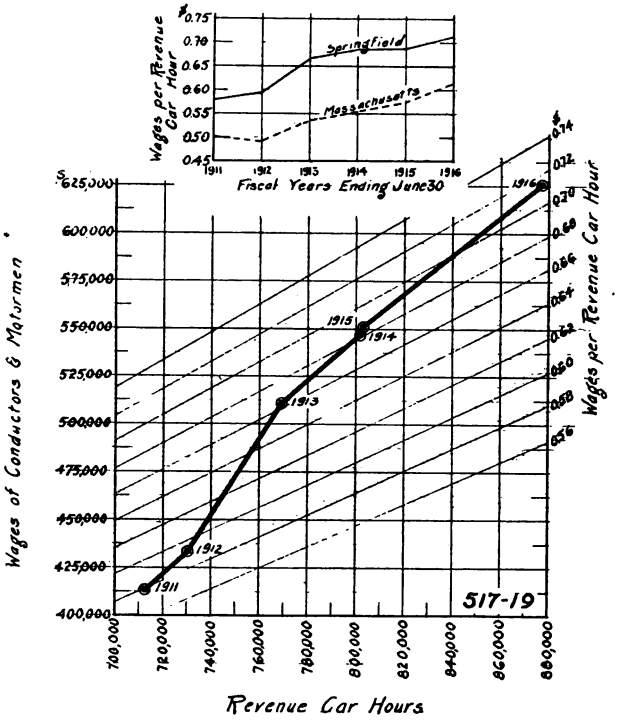
A comparison of the maintenance of equipment per car mile with the rest of the state, as shown by the small insert chart, illustrates the fact that the amount expended in Springfield on this account is usually one or two-tenths of a cent below the figure for the state, exceptions being the years of 1913 and 1916. As explained above, it is to be expected that the Springfield figure will again drop down to or below that for the state within the coming year.



Kilowatt Hours Per Car Mile

This chart shows kilowatt hours energy output of all stations plotted against total car miles, and the resultant figure, kilowatt hours per car mile, is shown by reference to the diagonal lines. The fluctuation in the energy consumption per car mile is due to a number of causes. The addition of larger and heavier cars, an increase in the number of stops per mile, an increase in

the number of passengers per car mile, less efficient handling of cars by motormen, or any of these factors, will tend to increase the energy consumption per car mile. On the other hand, additions in the nature of more efficient car equipment, increases in gear ratios, decreases in schedule speed and more efficient handling of car equipment by motormen, or any of these factors, will tend to decrease the energy consumption per car mile. All of these factors have at one time or another had their bearing on this phase of the Springfield operation, resulting in the energy consumption per car mile as shown, increasing in 1912, decreasing in 1913, again increasing somewhat in 1914, and considerably decreasing in 1915 and 1916.

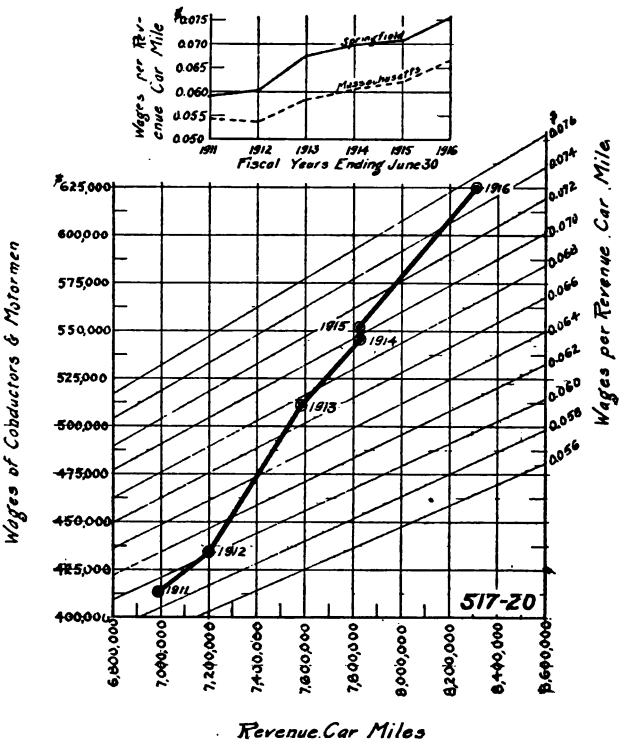


Wages of Conductors and Motormen

As stated elsewhere the expenses included in the general operating account "Conducting Transportation" have increased considerably in relation to other expenses and to revenues in

the past six years. Nearly the whole of the expenditures under "Conducting Transportation" are wage items, and at present more than five-sixths of the expenditures under this account are wages of passenger conductors and motormen. That item is therefore a very important one for consideration.

The chart on opposite page shows the wages of conductors and motormen plotted against revenue car hours. Reference to the diagonal lines on this chart show the wages of conductors and motormen per car hour increasing from 58c in 1911 to more



than 71c in 1916. As all but an infinitesimal part of the work of conductors and motormen is performed on an operating car, the amounts shown on this chart as wages per car hour represent exactly the average rate paid to each pair of men during the year, expressed in cents per hour for time actually worked on the cars. The average wage paid to the individual conductor or motorman was one-half of that amount, namely, 29c per hour

in 1911, increasing to nearly 36c per hour in 1916. This represents an increase in wages per hour, time actually worked, of nearly 25% between 1911 and 1916.

This probably is the highest average rate per hour paid to conductors and motormen by any street railway system in Massachusetts or New England. The small insert chart showing a comparison with the average of other street railways shows that the wages of conductors and motormen per car hour in Springfield were 8c greater than the state in 1911 and 10c greater than the state in 1916. In other words, the average individual conductor and motorman in Springfield is now receiving 5c per hour more than the average individual conductor and motorman elsewhere in the state, excluding Boston. This increasing cost to the Springfield Street Railway in wages to its employes is principally responsible for the increase in its total operating expenses, as noted on page 14, and shown by Charts Nos. 517-4 and 517-5.

Chart No. 517-20 on page 27 shows the same item of wages of conductors and motormen plotted against car miles and indicates an increase in wages per car mile, from less than 6c in 1912 to about 7½c in 1916. This chart also shows that Springfield is and has been paying about 1c per car mile more wages to conductors and motormen than has the average street railway in the state.

The discrepancy in the items of wages of conductors and motormen per car hour and per car mile between Springfield and the rest of the state is principally due to the fact that the Springfield company's wage scale is on the *daily* basis, a definite amount being paid for each day, irrespective of the time worked, up to nine hours, after which overtime is paid, while on all other roads in the state (and practically all other roads in the country) wages are paid on the *hourly* basis.

THE TRAFFIC SURVEY

A comprehensive survey of the movement of cars and passengers in the Springfield division was made during the period of January 22 to February 13, 1917. This survey was made on one or two routes at a time, record of the operation for one complete day on each route being obtained. Care was taken that observations were made only on days which were representative or typical on each individual route. For instance, no observations (which were finally used) were made on stormy days, but all were confined to days with typical winter weather. Previous to making observations, the receipts for individual routes were listed by days of the week, and a day was selected for each route which would be likely to represent it by the average travel. No observations were made on Saturdays or Sundays.

During the observation of each route, a special observer rode each car operating on that route, from the time it pulled out of the car house until it returned. In order to provide for meal reliefs and to furnish only a reasonable day's work for each observer, it was necessary to provide practically as many observers as conductors, and usually the conductors and observers operated in pairs. Herein arose the necessity for making the survey one of individual routes instead of observing the traffic for the whole city on one day. In order to accomplish the latter, it would have been necessary to employ as many special observers as there are conductors. Owing to the difficulty of employing capable men for a very short period, and also because each observer required some training, it was decided to make the observations on one or two routes at a time, using care, as before stated, that the day on which each route was observed fairly represented an average day's travel on that route. This is the method usually followed in making such surveys. When completed, the results can be combined and the fair assumption made that the combined figures represent one typical day's travel over the entire system.

Each traffic observer was furnished with specially prepared blanks, printed in two colors, one for each direction of travel. On each blank was printed a list of all regular stopping places

on the route from one end of the line to the other. On this blank the observer listed the following information:

The leaving time at terminals and at all junction points

At each stopping place, the number of seconds during which the car was at standstill. (Only about one-sixth of the total number of observers were asked to record this item)

The number of passengers boarding the car at each stopping place

The number of passengers leaving the car at each stopping place

Remarks as to cause of delays, etc.

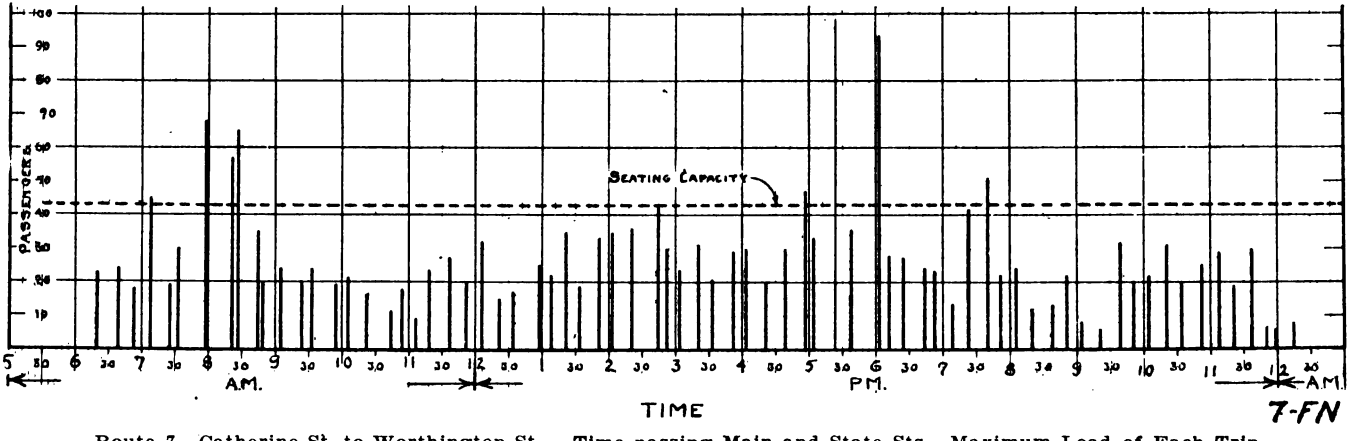
In addition to the data secured by the traffic observers, the conductors on the route under observation for the day were furnished transfers printed on paper of special colors, one color being issued on all trips going in one direction and another color being issued on all trips in the other direction, both colors being different from any other transfers used on the system on that particular day. Instructions were issued to the conductors that particular care should be taken in punching these transfers so that the correct time of issue and the correct route to which issued would be plainly and accurately punched.

It can be seen from the above that on completion of the observation we were in a position to analyze each half trip operated during a typical day. The reports of the traffic observers gave the actual time of each trip at each terminal and all junction points. One-sixth of the reports gave data from which the time required in boarding and alighting by various numbers of passengers and different types of cars could be analyzed. Delays could be analyzed as to location, cause, time of day and time consumed. The exact number of passengers on and off the car at every stop of every trip was available and from these figures the total number of passengers at any time or location during every trip could be ascertained. The extent of maximum loading and the point where it occurred in each trip could be determined. By a method which is described elsewhere in this report, it was possible to determine the average length of ride per passenger, either by individual trips, by routes, by hours of the day, or for the entire typical day. It was also possible to determine (by a method described elsewhere) the ratio between the number of passengers and the

number of seats for any particular period or route or for the entire day.

By a checking of the transfers collected on each day of the survey, the checkers noting especially the transfers of the colors other than the buff color ordinarily used, it was possible to determine the precise movements of passengers using transfers, namely, the route from which and to which transferred, together with the time of day.

A consideration of the number of half trips operated in Springfield during one typical day (namely, 3324) may perhaps enable one to realize the great amount of data collected in the traffic observations and the amount of labor required in making the calculations and drawing the deductions mentioned above. A complete analysis of the survey has not yet been made, although data is available for making all of the deductions mentioned, as well as others not listed. However, a sufficient analysis has been made to enable us to present a considerable amount of data, with the conclusions drawn therefrom as mentioned in the following pages of this report.



Route 7—Catherine St. to Worthington St. Time passing Main and State Sts. Maximum Load of Each Trip.

Description of Charts Used in Presenting Traffic Data

The principal items of information obtained through the traffic survey have been plotted by routes in the form of charts, which charts are included in a separate volume as a supplement to this report.

Each route as operated during the time of the traffic survey had an operating number assigned to it, and this number appears as the first character in the classification of these charts as grouped in the supplement. For instance, all charts relating to the Maple Street-Brightwood route are classed with number "1"; all charts applying to the Hancock Street-Feeding Hills route are numbered "6," etc.

For each route there are shown two charts similar to Chart 7-FN, which particular chart is reproduced for purpose of illustration on the opposite page. This chart may be called the "frequency of service" or "maximum load" chart, as it combines information relative to both matters. Such charts are designated in the scheme of numbering by the letter "F" following the number of the route, and further by either the letter "N" or "S" indicating whether the chart applies to the half trips operating in the north or south bound direction through Main Street. The sample chart on the opposite page indicates by its designating symbol "7-FN," first, that it is for the Catherine-Worthington Street line, which is route 7; second, that it is of the "frequency" or "maximum" class, and third, that it is for the half trips of this route which operate in the northbound direction through Main Street.

It will be noted that the chart is divided horizontally as to time of day between 5 a. m. and 1 a. m. Each vertical line resting on the base line indicates a car, the particular point at which it rests on the base line indicating the exact time at which the trip passed the time point chosen for the chart—in this case, Main and State Street, as noted on the chart. The chart is thus a "frequency of service" chart, because it indicates the regularity with which the various trips passed the time point at all times during the day of the survey.

By reference to the scale marked "Passengers" at the left of the chart, the height of each vertical line above the base line indicates the maximum number of passengers on the corresponding car during the half trip. Note that this is not the number of passengers on the car when passing the time point, but is the maximum number during the half trip *wherever such maximum occurred.* For instance, the car which passed Main and State Streets going toward Worthington Street at 12:05 p. m. carried as its maximum during that entire half trip 32 passengers, while the car which passed that point in the same direction at 12:20 p. m. carried as its maximum during that half trip 15 passengers. The horizontal dotted line indicates the average seating capacity of the cars used on the line—in the case represented by the sample chart, this is 43. Similar data for cars on this route in the opposite direction may be found in the supplement on Chart 7-FS.

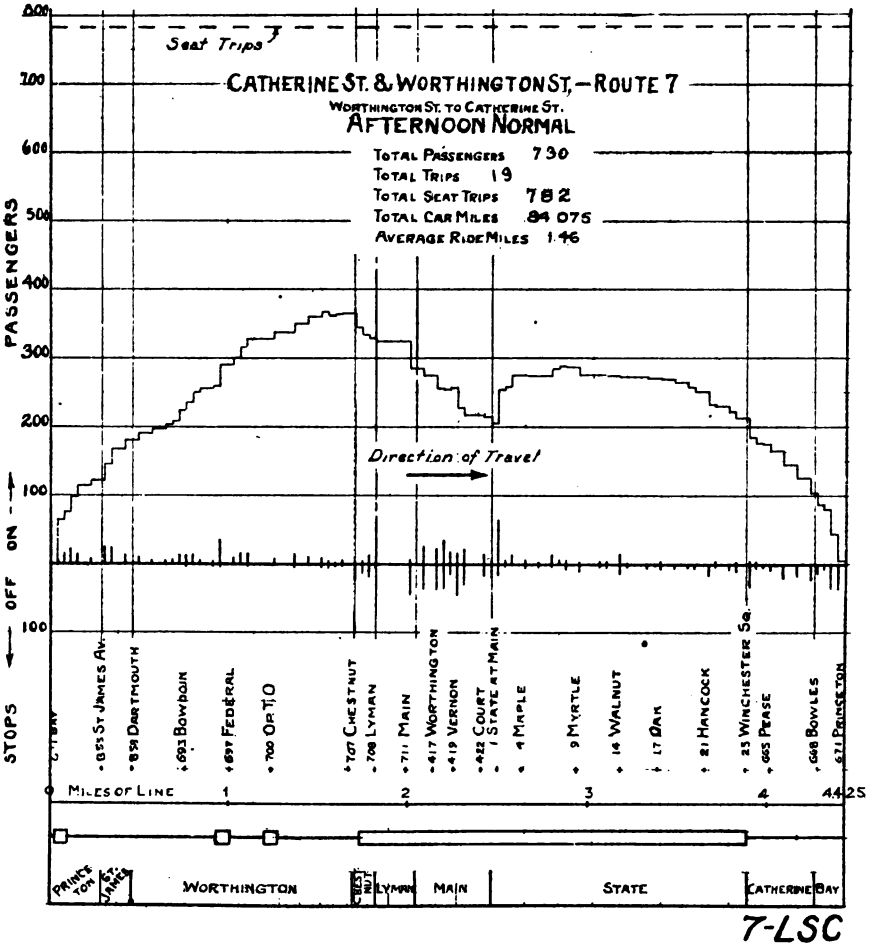
These "frequency-maximum" charts present some interesting data as to delays in operation and their effect on car loading. For instance, the trip shown on Chart 7-FN at 5:05 p. m. has a comparatively light load on account of its following so closely behind its predecessor which obviously has been delayed. The next following trip is also delayed, not reaching the time point until about 5:25 p. m. It consequently gets many more passengers than it should if on time, the chart showing 98 passengers as its maximum. The car following ten minutes later carried only 36 passengers, while the next car, which again was delayed, not arriving at the time point until after 6 p. m., carried as its maximum 93 passengers, being followed by succeeding trips none of which carried much more than the seating capacity. Obviously, had an even headway been maintained, a sufficient amount of service would have been provided between 5 and 6 p. m. so that none of the cars would have exceeded their comfortable standing capacity. Similar instances of irregular service producing uncomfortably crowded cars are illustrated on these "frequency" charts throughout the supplement, many being discussed in detail later in this report.

These "frequency" charts serve to indicate not only the regularity of service but plainly show the addition of extra cars to the service during morning and evening rush hours on such

routes where this is done, and also enable a determination to be made as to whether too much or too little service is being provided on any particular route during any period of the day.

Chart 7-LSC, reproduced on page 36 is a sample "characteristic curve" or "load curve," ten of which were made up from the traffic survey data for each of the routes. Here again the numeral of the chart indicates the number of the route, the sample chart being for the Catherine-Worthington Street line, route 7. On all of these characteristic charts, the route number is followed by the letter "L." Five charts were made for each route for each direction of travel, the second letter "N" or "S" indicating northbound or southbound through Main Street. One chart for each direction was made up for each of the various periods of the day, as follows: for the morning rush hours, 5:00 to 8:30 a. m., charts marked "A"; for the morning normal hours, 8:30 a. m. to noon, charts marked "B"; for the afternoon normal hours, noon to 4:30 p. m., charts marked "C"; for the evening rush hours, 4:30 to 6:30 p. m., charts marked "D"; for the night normal hours, after 6:30 p. m., charts marked "E." Due to the length of line, it was in some cases necessary to spread these individual charts over two sheets, such sheets being marked with the route number and the distinguishing letters as above, but followed, respectively, by the letters "a" and "b."

A discussion of the sample chart 7-LSC in some detail will suffice for all of the "L" charts included in the supplement. This chart is for the afternoon normal hours in a southbound direction through Main Street or from the Princeton Street terminal through Worthington Street to State Street and the Bay Street terminal. This direction of travel is indicated by the arrow. The length of the base line of the chart is laid out proportionally to the length of route in miles, as shown at the bottom of the chart—in this case, 4.425 miles. The various streets traversed by the route are indicated at the bottom of the chart, while a diagram just above indicates the double or single track sections and location of turnouts. The location of the principal cross streets is also shown to scale. Small vertical lines will be noted extending above and below the base line. The length of these lines above or below the base line indicates for the various stopping places on the route the number of passengers

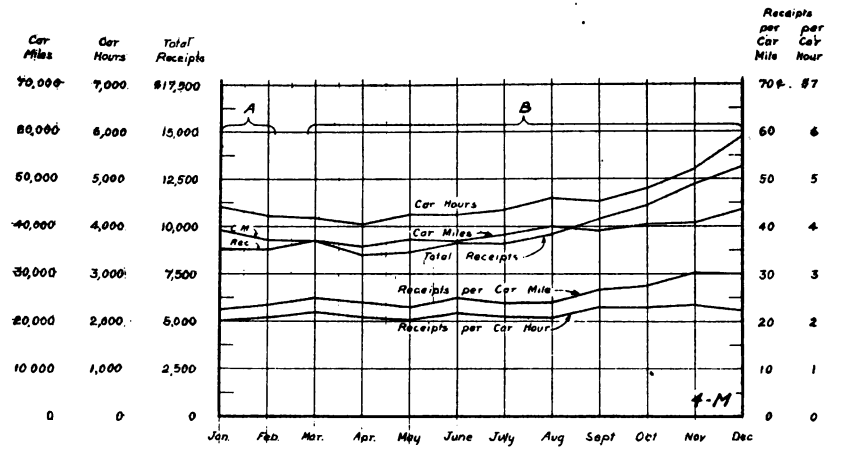

Seat Trips
CATHERINE ST. & WORTHINGTON ST. — ROUTE 7
WORTHINGTON ST. TO CATHERINE ST.
AFTERNOON NORMAL
TOTAL PASSENGERS 730
TOTAL TRIPS 19
TOTAL SEAT TRIPS 782
TOTAL CAR MILES 84 075
AVERAGE RIDE MILES 1.46
PASSENGERS
OFF ON
STOPS
Direction of Travel
C'TBAY
.851 St James Av.
.859 Dartmouth
.693 Bowdoin
.697 Federal
.700 Opt. O
.707 Chestnut
.708 Lyman
.711 Main
.417 Worthington
.419 Vernon
.422 Court
1 State at Main
4 Maple
9 Myrtle
14 Walnut
17 Oak
21 Hancock
23 Winchester Sq.
.665 Pease
.668 Bowles
671 Princeton
MILES OF LINE
0
1
2
3
4
4.425
PRINCE TON
LAST JAMES
WORTHINGTON
CHEST NUT
LYMAN
MAIN
STATE
CATHERINE
BAY

7-LSC

boarding or alighting at such stops, during the period noted. For instance, this chart indicates that on the trips run between noon and 4:30 p. m., 65 passengers boarded the eastbound cars of this route at Main and State Streets, and at the same stopping point 17 passengers alighted from these cars. The irregular shaped curve above the base line indicates the total number of passengers on the southbound cars of this route, during the period covered, at any point in the route. It is constructed by continually adding the number of passengers on and subtracting the number of passengers off. As thus constructed, the sample chart shows the maximum number of passengers as 367 between stops 703 and 704. These 367 passengers were, of course, distributed among the 19 trips embraced by the chart. The sample chart shows 65 passengers boarding at the Bay Street terminal, this increasing to a maximum, as noted, of 367 at stop 703, then decreasing to a minimum of 205 at State and Main Streets, increasing to a second high point of 290 at stop 7, and then gradually decreasing until all passengers have been distributed, the last few leaving at the Bay Street terminal. The dotted line at the height corresponding to 782 passengers indicates the total number of seats furnished during the period covered by the chart. The area included under the dotted line is a measure of the seats furnished or service offered during the period covered, while the area under the passenger load curve represents the use of such service. The relative size of these two areas indicates the "load factor," or relation between service used and service offered, for this particular route, direction and period. By adding the total number of "passengers on" throughout the route, the total number of passengers carried on this route in this particular direction and during this particular period may be obtained, as shown by the chart, 730. If the area under the passenger load curve be integrated, the total number of passenger-miles represented on this chart can be calculated—in this case, 1066. If this total number of passenger-miles be divided by the total number of passengers on the chart (730), the result will give the average ride in miles for these passengers—in this case, 1.46 miles. On each of the "L" charts, as shown in the supplement, a tabulation shows the total number of passengers, the total number of trips, the total num-

ber of seats, the total number of car miles and the average ride per passenger. Combining the figures shown on the ten "L" charts for each route, it is possible, therefore, to obtain such total and average figures for each route. By making a combination of the "L" charts for any particular period of the day, similar total and average figures may be obtained for the entire division for that particular period of the day, and further by combination of the figures shown on all "L" charts, total passengers, trips, seats, average load factor and average ride per passenger for the system may be obtained. Such a tabulation is shown on page 49 of this report.

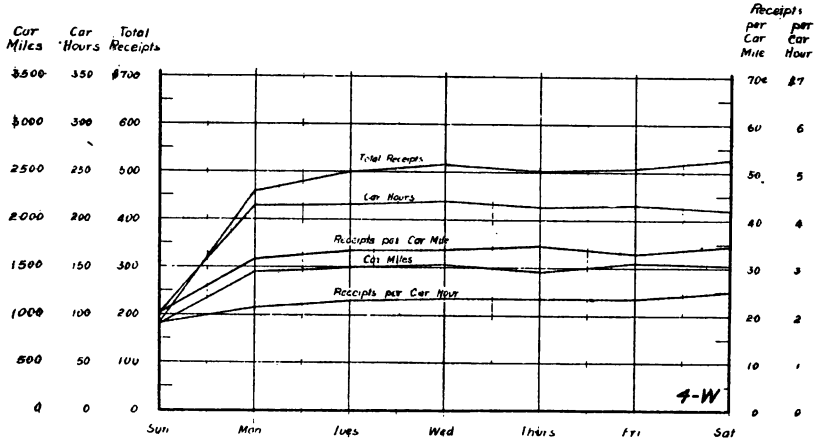
In addition to charts as described above, the material for the construction of which was obtained directly from the traffic survey, other charts based on figures furnished by the Auditing Department are included in the supplement, as described below.



NOTES. A. Miltineague via St. James Avenue and East Springfield to Chicopee Falls.
B. Wason Avenue via St. James Avenue and East Springfield to Main Street, Chicopee Falls.

A chart of monthly variation in receipts and service for the year 1916, similar to sample chart 4-M as shown on this page, is included for each of the routes. Sample chart 4-M is for the St. James Avenue-Brightwood line, route 4, and shows the variation in total receipts, car miles, car hours, receipts per car mile and receipts per car hour, by months for the year 1916. Where any change in routeing occurred during the year, such change is noted on the chart, sample chart 4-M showing such a

change in that this route 4 had its western terminal in Mittineague during January and February and at Wason Avenue in Brightwood during the balance of the year. These charts not only show seasonal variation in receipts and service, but also show the variation due to change in the routes or to riding conditions on any particular route. The steady climb of the total receipts, as shown on the sample chart beginning in July, indicates the growth of business on this route due almost wholly to the increased travel to and from the Westinghouse works in East Springfield.



A chart of daily variation in receipts and service for one typical week (January 7-13, 1917) was constructed for each route. These charts are similar to sample chart 4-W on this page, this being for the St. James Avenue-Brightwood line, route 4. These charts show the variation from day to day in the items of total receipts, car miles, car hours, receipts per car mile and receipts per car hour, thus indicating the variation in business and service due to day of the week, the former usually showing a decided drop on Sunday and frequently an increase on Saturday, each route having its own characteristics in this respect. In some cases it will be noted that such decreases and increases are properly followed by service changes. In other cases, it will be noted that the service is not changed proportionately to the change in business. In some of these cases, it is possible to recommend some advantageous change, in others, not.

The individual routes are discussed later in this report.

Transfer Traffic

From \ To	State St. Lines	S. Main St. Lines	N. Main St. Lines	West Side Lines	N. Chestnut St. Lines	Plainfield St. Line	Liberty St. Line	Worthington St. Line	(Ludlow) to Sp'f'ld	(Longmeadow) to Sp'f'ld	(Chic.) to Sp'f'ld	(Chic. F.) to Sp'f'ld	Totals
State St. Lines	1,957	1,614	863	940	355	113	243	49	45	—	7	168	6,354
S. Main St. Lines	2,143	434	371	727	290	24	314	117	9	9	37	103	4,578
N. Main St. Lines	766	238	8	263	74	5	100	44	—	—	6	—	1,504
West Side Lines	922	550	510	423	78	57	151	61	—	—	—	41	2,793
N. Chestnut St. Lines	131	121	56	66	2	17	9	18	—	—	—	—	420
Plainfield St. Line	119	26	33	73	9	—	33	11	—	—	2	—	306
Liberty St. Line	21	18	1	4	—	5	7	—	—	—	—	—	56
Worthington St. Line	56	99	65	70	25	7	5	—	—	—	—	12	339
Chic. (Glen.) in Chic.	210	87	17	38	—	2	21	5	—	—	—	4	384
Chic. F. Line in Chic. F. .	267	260	90	154	71	26	7	14	—	—	—	—	889
(Ludlow) Sp'f'l'd Line ..	47	10	42	19	2	—	6	1	—	—	—	—	127
Totals	6,639	3,457	2,056	2,777	906	256	896	320	54	9	52	328	17,750

Transfer Data

The special form of transfer used on each route during the period of the traffic survey enabled a classification to be made showing the number of persons transferring from each half route to all other half routes, further classified as to the hour of the day in which such transfers were made. Tabulations setting forth such data have been made, but obviously are too bulky to be included in this report.

The tabulation shown on the opposite page is a general summary of this information and shows in a general way the transfers used on routes in various districts, together with the routes which issued them, also similarly classified by districts. This general summary tabulation shows in each case the number of transfers used during the entire combined day of the traffic survey. The detailed tabulations not here included show not only data for each half route separately, but also further classify the use of transfers between half routes as to the hour of the day in which used.

Such data are extremely valuable in determining the proper routeing of cars and were to a large extent responsible for the changes in routes which were made on March 18, 1917, after the completion of the traffic survey.

Service Standards and Car Data

Theoretically the headway of cars should be based upon a predetermined relation between the number of passengers carried and the number of seats furnished during a given period of time. However, the principle that this relation between passengers and seats furnished may vary at different times of the day is a vital one where the characteristics of traffic show definite rush hour periods, and this principle has been definitely recognized by the rulings of various commissions.

In almost every case, different service standards are prescribed for the rush hour periods and for the normal or non-rush hour periods, and in some cases an intermediate standard is prescribed for the transition period between the rush and non-rush hours. Such variation of the service standard during various hours of the day is in recognition of the fact that it is impracticable to furnish a seat for every passenger during the rush hour period at the existing rates of fare.

Mr. B. J. Arnold, in his report on the Pittsburgh transportation problem, recognizes the further principle that the service rendered must bear some relation to its cost, and states the solution as follows:

"The working out of the whole problem . . . starts with determining definitely how much of the income is available for service, then how many car miles this appropriation will supply, and finally what disposition of this service will best supply the demands for seats."

Service standards are usually based on the following considerations: For the normal or non-rush hour period, a seat is furnished for every passenger, and in addition, the headway must be sufficiently short to avoid unreasonable waits for cars; the determination of a reasonable wait being based on the length of ride, amount of patronage and the amount of competition (such as jitneys). For the rush hour period, the service standard usually is based upon the car capacity including both seating and standing room. The seating capacity usually is figured on the basis of about eighteen inches of seat per passenger, and the standing room is customarily determined by dividing the floor area, measured in square feet, by 2, 3 or 4. In a longitudinal

bench car, about eight inches is added to the seat room to allow for knee room, and the floor area devoted to fare boxes, control apparatus, etc., is also deducted when estimating the comfortable standing room.

In this connection, it is interesting to note that standards adopted by the U. S. army are based on the experience that an area of 3.35 square feet per person will permit free manœuvering.

The 1911 report of Messrs. Ford, Bacon and Davis to the Pennsylvania State Commission in the matter of service on the lines of the Philadelphia Rapid Transit Company, states that four square feet per standing passenger provides sufficient room for comfort and for free movement through the car, and states that the total seated and standing capacity of the interior of the car will equal about 3.5 square feet per total seated and standing passenger.

In the report of Mr. B. J. Arnold on transportation facilities in the city of San Francisco, 1913, it is recommended that reasonable standards to be applied to all types of cars are as follows: (1) comfortable standing, 50 per cent in excess of cross seats, and 100 per cent in excess of longitudinal seats, plus platforms; (2) normal maximum capacity, three square feet per standing passenger; (3) emergency maximum capacity, two square feet per standing passenger.

There is, of course, considerable danger in attempting to apply service standards as promulgated in one city to the regulation of the service of companies operating under essentially different conditions. The references which have been given, however, indicate that there are certain factors which must be considered in order that substantial justice may be shown to the patrons and company alike. These considerations embrace the capacity of the car used, the fluctuation or diversity factor in car loading, the variation in passenger demand, and the cost of service.

In connection with the determination of car capacity, it should be noted that there are a certain number of passengers who will stand by preference, irrespective of whether or not seats are available. The number of such preferential standers varies with the conditions existing in various localities. For

DATA ON CLOSED CARS

Number, Type and Passenger Capacity

No. of Cars	Length	Description*	Standing Room Sq. Ft. Per Car	Passengers				Per cent Standing to Seated
				Per Car		Total		
				Seated	Stand'g	Seated	Standing	
7	20′	S	61.6	24	20	168	140	83.3
1	20′	S P	61.6	24	20	24	20	83.3
7	18′	S	57.6	26	19	182	133	73.1
46	20′	S	61.6	26	20	1196	920	76.8
5	20′	S	61.6	28	20	140	100	71.4
12	25′	MD	107.6	32	36	384	432	112.5
2	25′	D	74.9	36	25	72	50	69.5
38	28′	MD	113.0	36	38	1368	1444	105.5
3	30′ 3″	D	93.2	40	31	120	93	77.5
3	30′	D	99.3	40	33	120	99	82.5
1	30′	D P	99.3	40	33	40	33	82.5
5	29′ 9″	D	86.9	42	29	210	145	69.0
4	30′	D	88.9	42	30	168	120	71.4
4	30′	D P	83.7	42	28	168	112	66.6
1	30′	D P	84.1	42	28	42	28	66.6
6	30′	D P	88.9	42	30	252	180	71.4
1	30′	D P	89.4	42	30	42	30	71.4
9	30′	D P	99.3	42	33	378	297	78.6
2	33′	D	121.6	43	40	86	80	93.1
6	30′	D	86.7	44	29	264	174	65.9
7	30′ 3″	D	93.2	44	31	308	217	70.4
4	30′	D	99.7	44	33	176	132	75.0
4	30′ 5″	D	104.0	44	34	176	136	77.3
2	30′ 9″	D	106.3	44	35	88	70	79.5
6	30′	D	116.5	44	39	264	234	88.6
3	33′ 4″	D	130.4	44	43	132	129	97.8
1	30′ 3″	D P	93.2	44	31	44	31	70.4
1	30′ 5″	D P	104.0	44	34	44	34	77.2
15	28′ 6″	D P	105.1	44	35	660	525	79.6
21	30′	MD P	116.5	44	39	924	819	88.7
4	30′	D P	99.3	46	33	184	132	71.8
4	35′	D	130.4	48	43	192	172	89.6
13	34′	D P	117.3	52	39	676	507	75.0
248	Total, all cars		23372.2			9292	7768	83.6
	Average car		94.2			37.5	31.3	83.6

* S — Single truck (66 cars)
D — Double truck (182 cars)
M — Maximum traction truck (71 cars)
P — Prepayment (78 cars)

instance, investigation has shown that 21 per cent of any load will stand by preference in Madison, Wisconsin; in La Crosse, 15.5 per cent; in Milwaukee, 19 per cent; in Lincoln, Nebraska, 14 per cent; in Cincinnati, 15.5 per cent; and in Springfield, about 10 per cent.

A table of data on closed cars of the Springfield Street Railway is shown on the opposite page. In this table the cars are listed by classes, sub-divided according to the length of car body, whether single or double truck, whether prepayment or not, and with further sub-divisions as to the number of seats and the square feet of standing room available after deducting for knee room and for conductor's and motorman's position, including the apparatus used by them. The number of standing passengers for each class of car has been calculated by allowing an area of three square feet per standing passenger. As noted in the last column of the table, the per cent of standing to seated passengers on that basis varies from as low as 66% in the case of six 30-foot cars to as high as 112% in the case of twelve 25-foot maximum traction double truck cars. The grand average for the 248 cars operated by the Springfield system shows standing room for a number of passengers equal to 83.6% of the number of total available seats. Due to the fact that some authorities consider 4 square feet of standing area the proper amount to be allowed per passenger, and further due to the fact that in the case of about 15% of the cars the standing room figured on the 3 square feet basis runs under 75%, it has been considered best to reduce the 83.6%, as shown on this table, to 75% as the figure to be used for Springfield rush hour conditions. In other words, in the present consideration of data from the traffic survey, the proper total capacity of the Springfield cars is considered to be 75% in excess of the seating capacity during rush hour periods. This allows a total of 77 passengers for the ordinary 44-seat car during rush hours. It should be understood, however, that such a standard should not be applied to individual car units, but should be applied as the average of the number of cars in the same direction on the same route in any one 15-minute period for five successive week days. It is necessary to apply such a service standard to some such average of cars during a certain period and over a period of several

days, in order to provide against the contingencies of irregular travel, as mentioned in the report of the Joint Commission on Investigation of the Service of Street Railway Companies (Second Annual Report of the Massachusetts Public Service Commission, Vol. I, page 408) as follows:

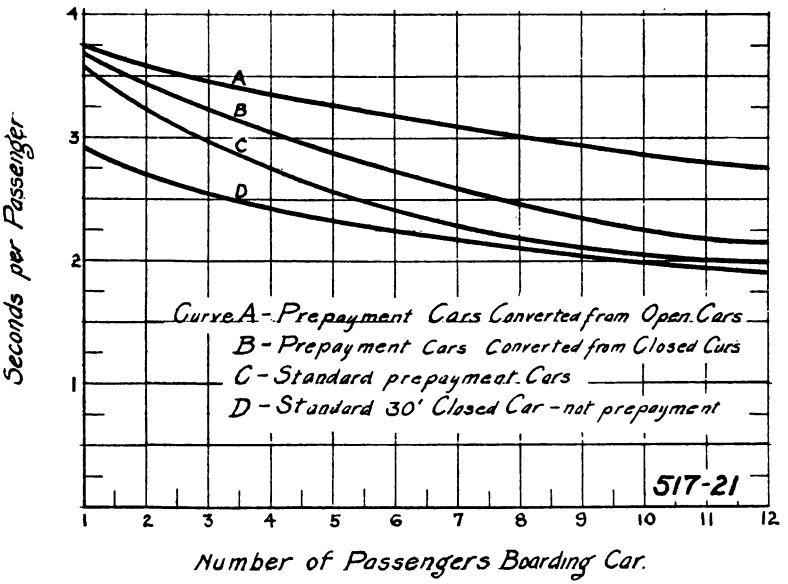
"While any such rule might tend to relieve the present congestion of street railway travel, it is also open to serious objection. As we have already indicated, it would probably prove very difficult of enforcement when a multitude of people present themselves for admittance to a car and insist upon getting on. The enforcement of any inflexible rule of this character might also produce considerable hardship. For instance, a night car running once an hour may ordinarily carry but ten or twenty people. Some night an unexpected contingency occurs and a hundred people or more attempt to crowd upon the car. It would be a great injustice to force them to wait an hour for another car, and the company can hardly be expected to be prepared at all times for unforeseen exigencies of this kind."

Further study of the data on closed cars, as shown in the table on page 44, shows that 66 of the total number of 248 closed cars are of the small single truck type with 18 to 20 foot body, seating from 24 to 28 passengers. These are the older cars of the company and are used only when their slight additional capacity is required in rush hours. These cars are not economical in operation, as their operating costs per car mile are nearly as high as those of cars of double the capacity, and the policy of the company includes the gradual retirement of this equipment as fast as it is financially able to provide new and larger equipment for its replacement.

The remaining 182 cars are double truck, only 14 of them being less than 28 feet in length and only 12 being less than 36-seat cars. Of these 182 cars 71 are equipped with the so-called "maximum traction" trucks and two motors. The balance have trucks with wheels of equal size for four motors per car. All of these 182 cars may be considered of fairly modern type. 78 of them are equipped for prepayment operation. All new cars which have been bought within the last two years have been of the prepayment type, and in addition, the company has reconstructed a number of its older cars for prepayment operation by removing bulkheads, installing mechanically-operated doors and fare boxes. It is understood that the policy of the company

contemplates a further rebuilding of this older equipment to the end that ultimately all cars will be of the prepayment type. Good operation dictates that this change should be made as soon as the company is financially able to make it.

Included in these cars which have been rebuilt for prepayment operation are 28 cars which formerly were open cars. These are listed in the table on page 44 as "fifteen 28 ft. 6 in." and "thirteen 34-ft." cars. Necessarily, these cars have a considerably narrower entrance, which permits of the entrance or exit of but one passenger at a time. This, together with the two outside steps, makes these cars somewhat slower in loading and unloading than the standard prepayment type where two persons can board or alight simultaneously and where the last step to the car floor is between the platform and the car body proper. Chart No. 517-21, below, compares the loading time per passenger of the various types of cars for various numbers of passengers boarding at one loading point, and brings out the fact that, compared with the standard prepay-



Loading Time per Passenger with Various Types of Cars.

ment cars, the cars converted from open cars require from one-quarter to three-quarters second more time per passenger in loading. While it might be considered a serious error to purchase new cars with such step and platform arrangement, on account of the considerably longer loading time required, the Springfield Street Railway cannot be censured for so reconstructing these open cars, as it makes a large portion of the equipment available for all-year-round use, which formerly was limited to a few months' annual use during the summer season.

All closed cars which have been purchased since 1914 have been equipped with about 65% of the seating capacity in cross seats, so that the passenger faces the front of the car. This is considered to be a more comfortable position for the passenger, but on account of the short haul on many of the Springfield city lines, it is doubtful whether the policy of equipping all cars with so many cross seats is advisable, due to the fact that such construction materially reduces the available standing area. It would seem that for routes where the haul is short and the rush hour loads large, economy would dictate the use of a car with longitudinal seats throughout its length.

Adequacy of the Present Service

Some general conclusions can be drawn from a study of the general data rendered by the traffic survey, as well as those which specifically apply to individual routes. Data of a general nature is included in the tabulation below. These data apply to the entire Springfield division or central five-cent fare zone of the railway. The table shows for the entire day of the survey, and also divided into periods, the total number of passengers carried, the total number of passenger-miles travelled and the total number of seat-miles furnished. These three items are also shown in the form of averages per hour, *i. e.,* the average passengers per hour, passenger-miles per hour, and seat-miles per hour, during the different periods, as well as for the entire day.

The load factor as shown is the number of passenger-miles divided by the number of seat-miles. This is, in other words, the percentage of service rendered which is used.

Passengers, Passenger-Miles, Seat-Miles, Load Factor and Average Ride Per Passenger

Period	Total Passengers	Total Passenger-Miles	Total Seat-Miles
5:30 a.m.—8:30 a.m.	32155	82605	132958
8:30 a.m.—noon	17299	41219	131106
noon —4.30 p.m.	34582	81771	175717
4:30 p.m.—6:30 p.m.	33216	82474	111074
6:30 p.m.—12:30 a.m.	32482	75290	225136
Entire day	149734	363359	775991

	Pass. per Hour	Pass.-Miles per Hour	Seat-Miles per Hour	Load Factor	Av. Miles per Pass.
5:30 a.m.—8:30 a.m.	10718	27535	44319	62.2%	2.57
8:30 a.m.—noon	4943	11777	37459	31.4%	2.38
noon —4.30 p.m.	7686	18171	39048	46.5%	2.36
4:30 p.m.—6:30 p.m.	16608	41237	55537	74.3%	2.48
6:30 p.m.—12:30 a.m.	5414	12548	37523	33.4%	2.32
Entire day	7881	19124	40842	46.8%	2.43

The average ride per passenger as shown is deduced as explained on page 37. As the total passengers indicated in this table include both those who pay cash, those who pay a cash ticket, those who ride on transfers, and free passengers, it will be seen that the average ride as shown is the average single ride of all passengers, including rides on transfers. As 15.7% of all passengers in the central five-cent fare zone (except passes) ride on transfers, it can be seen that the figures given in this tabulation under the heading "Average Miles Per Passenger," must be divided by 0.843 in order to get the average ride of cash and cash ticket passengers including the ride on transfer when used. This will increase the average ride per passenger for the entire day from 2.43 miles, as shown by the table, to 2.88 miles. The figures as shown by the table may, however, be used for comparative purposes and show that the morning rush hour passenger rides 6% further than the average, that the evening rush hour passenger rides 2% further than the average, and that the passengers during the non-rush hours ride from 2% to 5% less than the average.

The rush hours between 5:30 and 8:30 a. m. and between 4:30 and 6:30 p. m. comprise only five of the nineteen hours considered, or about 25% of the time. During this period, however, more than 65,000 passengers, or nearly one-half of the total, are handled.

The load factor, which is the relation between service used and service rendered, varies considerably between the various periods. Standing at an average of 47% for the entire day, it is increased by about one-third to 62% during the morning rush, is increased by more than one-half to 74% in the evening rush, falls to about 31% in the morning normal hours, is about at the average of 47% during the normal afternoon hours, and again falls to about 33% after the evening rush hour. This indicates by definite figures what in a general way is very evident, namely, the much larger use of the facilities offered during the evening rush hour than at any other period of the day. It shows also the very limited use of the facilities offered during the hours between 8:30 a. m. and noon and after 6:30 p. m., and suggests the possible advisability of some reduction in the service rendered during these hours. If it were possible to take service out of these light hours and put it into the rush hours, especially be-

tween 4:30 and 6:30 p. m., to the same amount and at the same cost, the net result would be a much improved service. It should be realized, however, that, especially during the evening rush hours, the railway has in service all of its available equipment, so that in order to transfer any car miles from the slack periods into the evening rush periods, it will be necessary to provide additional equipment, and enough additional return must be earned in the short evening rush hour period to pay not only operating expenses, but the fixed charges incident to the additional investment so required. Such additional investment would include that not only in rolling stock but in additional trackage which may soon be necessary if the evening rush hour loads are increased.

Not only would it be necessary for additional rush hour service to pay increased fixed charges, but if evening rush hour service is increased, it must pay a very much larger per cent of operating expenses than is required by non-rush hour service. Wages of conductors and motormen amount to about 36% of the total operating expense and may be so considered for the normal or average hours. Due to the peculiar form of agreement between the Springfield Street Railway and its conductors and motormen, it is required to pay a full day's wage to any man who works even so short a time as one hour during the day. The addition of a considerable amount of short rush hour service in Springfield would therefore mean that the wages of conductors and motormen for such short period cars would amount to three to five times the amount paid for such services per hour during the normal hours. If such short period cars are not operated by men who make this their full day's work, they must be operated by men who have already done a day's work on an all-day car, and in such case the "intervening time" and overtime required by the wage agreement would make the average wage *per hour actually operated* on these proposed additional evening rush hour cars practically the same as that estimated above, namely, three to five times the average normal hour rate. It must be seen, therefore, that no even interchange of service can be made by reducing the non-rush service and correspondingly increasing rush hour service, but whatever interchange is made must be with due regard to the comparative expense of operation in the two periods.

In a detailed consideration of routes which follows, a number of definite recommendations are made relative to decrease of non-rush hour service and increase of rush hour service. Non-rush service may often be decreased to advantage, as a study of the individual charts shown in the supplement of this report will indicate, by a cutting off of non-productive service furnished to the outer ends of long routes. A large portion of such service might well be converted into service on short haul routes through the center of the city where jitney competition is most active, it being especially recommended that the service be increased on Main and North Main Streets between Brightwood and Sumner Avenue and on State Street as far out as Winchester Square or Benton Street. It is especially recommended that service in these sections be increased during the evening rush hours, as most of the overloads shown by the traffic survey occur through these sections. This recommendation must necessarily depend on some form of relief for the congestion of Main Street, as discussed elsewhere in this report. If the service on Main and State Streets be increased as recommended, it would then be possible and desirable to operate through cars, such as those to Chicopee, the Longmeadows, Indian Orchard, etc., as "express" or "limited stop" cars through the sections mentioned, thus in a measure reserving the long route cars for long haul passengers and more nearly confining the short haul passengers to the short haul cars. As discussed elsewhere, the only way in which to increase the profitable length of haul on these long routes is to increase the load factor throughout the route, and this can be done only by keeping the short haul passengers off the long route cars.

The effect of track capacity on rush hour business on some of the outlying lines is discussed later in the detailed consideration of specific routes.

The car flow diagram shown on the insert page opposite shows the number of cars operating on various sections of the streets in the downtown district during the evening rush hours between 4:30 and 6:30 p. m., at the time of the traffic survey. It will be noted that on Main Street, especially between Lyman and State Streets, the number of cars in each direction is well over 200 during the two hours, or considerably more than 100 in the heaviest hour. Suggestions are made elsewhere in this

C31 S1269
Court Square
C190 S7227
C211 S8023
C144 S5400
C80 S3139
Main St.
Main St.
C54 S2424
Plainfield St.
C54 S2095
C54 S2131
N Main St

report relative to a possible reduction in this large number of cars. As there noted, such reduction may be made by keeping most of the suburban and interurban cars off Main Street entirely during rush hours, this including such cars as may cross the river over the proposed new bridge from the west side. If the short haul service, as recommended above, be given, it is probable that most of the cars taken off Main Street, by the recommendations noted, would be replaced by these short haul cars. It seems, therefore, absolutely necessary that the relief of Main Street congestion be had by the adoption of measures other than a net reduction in the total number of cars passing through it. Such measures, as discussed elsewhere, include principally a larger co-operation between the city and the railway company in a better regulation of traffic and a more lively operation of cars through this section.

Consideration of the details of the traffic survey by routes follows.

Maple Street—Brightwood, Route 1

From Water Shops via Central, Maple, State, Main and North Main Streets to Hooker Street, with a portion of the trips extending through to the end of the double track at the Chicopee Line.

During 1916, this route operated as described above during January and February. In March and April the operation was the same except through Dwight Street. On November 14 the northern terminal of the route, except for a portion of the trips, was made at Hooker Street. On March 18, 1917 (since the traffic survey was made) the northern end of the route was changed to omit North Main Street and extend through Carew and Chestnut Streets to Hamburg Street in Glenwood. (See recommendation relative to present routeing, in connection with route 22.)

The monthly variation chart (Supplement sheet 1-M) shows the effect of the above changes (except the last) to be of no great consequence except that the November 14 change, namely, the cutting back of the route to Hooker Street, shows an increase in receipts per car mile accompanied by a decrease in receipts per car hour, indicating a slowing up of average speed on

the route. The former shows that this change would have been advisable had it not been accompanied by the corresponding decrease in speed.

A study of the chart of daily variation in receipts (Supplement sheet 1-W) shows the same number of car miles and car hours operated during the various days of the week. The total receipts show the normal increase which might be expected on this route on Saturdays, which is reflected in the receipts per car mile and per car hour.

The maximum load charts (Supplement sheets 1-FN and 1-FS) show, northbound, few trips where the seating capacity is exceeded, only one trip, that passing Main and Carew Streets at about 5:50 p. m., having a load exceeding the comfortable standing capacity. Southbound, a larger number of trips are shown where the seating capacity was exceeded. The trip passing Main and State Streets at 5:30 p. m. had a standing load nearly equal to the seating capacity, this being no doubt due to delays which made this trip several minutes late, taking up passengers who otherwise would have been left to the succeeding car.

A study of the ten characteristic curves of this route (Supplement sheets 1-LNA and 1-LSE, inc.) shows that by far the largest number of passengers handled on this route are on the Maple-Central Street end. Sheet 1-LND shows that one northbound trip carried 100% in excess of seating capacity mentioned above as shown on Sheet 1-FN. This overload occurred north of Hooker Street. Such overload could have been prevented by running more than this one trip during the evening rush hour north of Hooker Street. Both north and southbound the route shows the greatest travel between Pine and Main Streets. The morning normal characteristics, Sheets 1-LNB and 1-LSB, together with the portion of the maximum load charts 1-NF and 1-FS, between the hours of 8:30 a. m. and noon, clearly indicate that a 20-minute headway could be maintained to advantage during these hours, replacing the present 15-minute headway.

The characteristic curves also indicate the advisability of the change in the north end of the route which was made on March 18.

Crosstown—Walnut St. and Forest Park, Route 2

As operated between April, 1916, and March, 1917, this route extended from Main and Lyman Streets, through Main, State, Walnut and White Streets, Sumner and Ft. Pleasant Avenues, Locust, South Main, State, Dwight and Lyman Streets to the point of beginning. The return trip extends from Main and Lyman Streets, through South Main Street and the above streets in the reverse direction through State, Dwight and Lyman Streets to the point of beginning. During January and February 1916, the northern terminus of this route was Wason Avenue in Brightwood. On March 18, 1917, this route was changed to the plain belt line, as noted above, except that the cars do not now go north of State Street on either Dwight or Main Streets, westbound cars on State Street proceeding through to Main Street where they turn south, and cars northbound on South Main Street turning east on State Street.

The chart of monthly variations during 1916 (Supplement sheet 2-M) shows the largest total receipts on this route during January and February when its northern terminus was in Brightwood. The receipts per car mile and per car hour, however, were practically the same during this period as in the later period when the Brightwood end was cut off.

The daily variation chart (Supplement sheet 2-W) shows total receipts fairly constant throughout the typical week except for a falling off on Sunday and an increase on Saturday, which are to be expected. The car miles and car hours are constant throughout the week except for a falling off on Sunday due to the later starting of the cars, so that the receipts per car mile and per car hour remain fairly constant throughout the week except for the normal increase on Saturday.

The maximum load charts (Supplement sheets 2-FN and 2-FS) show several trips which are in excess of the comfortable standing capacity. Inbound on Walnut Street and outbound on South Main Street, such trips are at 8 a. m. and between 6 and 7:15 p. m. Inbound on South Main Street and outbound on Walnut Street, such trips are between 7:30 and 8:20 a. m. and at about 6:30 p. m.

The characteristic curves (Supplement sheets 2-LNA to 2-LSE, inc.) show the heaviest travel on this line as follows:

during the morning rush, inbound on Walnut Street to the junction with State, and inbound on Sumner Avenue and South Main Street to the junction with State; during the afternoon, and especially in the rush hour period, the travel is heaviest outbound on South Main Street and Sumner Avenue, and also on State and Walnut Streets. During no time of the day is travel heavy in either direction on White Street, and it is possible that during the normal hours of the day some car miles and car hours might be saved by making the terminals of the route for one-half of the cars at the Water Shops in one direction and at Sumner Avenue and White Street in the other direction, thus reducing the service on White Street to 30-minute headway. The characteristic curves show the advisability of the change which was made in March 1917, as noted above. Some of the car miles saved by reducing the service on White Street might be employed by an increase of the service during the evening rush hour on Walnut Street and on South Main Street, if equipment were available.

King-Chestnut Streets, Route 3

This route extends from Alden Street, through Eastern Avenue, King, Walnut, State, Main, Carew and Chestnut Streets, to Hamburg Street in Glenwood. During the greater portion of 1916 the route operated as noted above, except through Lyman Street instead of Carew between Chestnut and Main Streets. On November 13, 1916 the northern terminal was made Calhoun Park, but the route was extended to Hamburg Streets. On November 13, 1916, the northern terminal was ern terminal of the route was made on Lyman Street, the cars being operated around the Dwight and Main Street loop, while the Chestnut Street end was taken care of by the change in route 1, as previously noted.

The 1916 monthly variation chart (Supplement sheet 3-M) shows the increase in service in March 1916 to be accompanied by a falling off of the receipts per car mile and per car hour. This chart also shows the reduction in car miles and car hours and consequent increase in receipts per car mile and per car hour, due to the cutting off of service north of Calhoun Park during November and December, 1916.

The daily variation chart (Supplement sheet 3-W) again shows the effect of heavier riding on Saturday, as reflected in total receipts, as well as receipts per car mile and per car hour.

The maximum load charts (Supplement sheets 3-FN and 3-FS) show few northbound trips with loads in excess of the comfortable standing capacity, such as are shown being plainly due to irregularity in headway. Southbound, one trip only, at about 7:50 a. m., shows an excessive load. If this is a daily occurrence, due to school travel, the condition should be remedied by the operation of an extra car double-heading this trip. During the evening rush hour, a number of trips are shown with more than seating capacity, but if a more regular headway had been maintained, none of these should have exceeded the comfortable standing capacity.

The characteristic curves (Supplement sheets 3-LNA to 3-LSE, inc.) show the heaviest travel on State and Walnut Streets and indicate clearly the advisability of the change made on March 18, 1917, whereby the Glenwood end of the route was cut off.

See page 72 as to operation through Chestnut and Carew Streets.

Wason Ave.—East Springfield, Route 4

This route extends from Wason Avenue through North Main, Main and State Streets, St. James Avenue and Page Boulevard to the Westinghouse works in East Springfield. Part of the trips run through, via East Street to Chicopee Falls. During January and February, 1916, the western terminus of this route was at Mittineague.

The monthly variation chart (Supplement sheet 4-M) shows a gradual and constant increase in receipts during the last half of 1916. That an attempt has been made to follow this increase in business with service is indicated by the fact that the car hours operated increase in nearly the same proportion. Failure to fully provide service proportionate to the increase in business is indicated by the fact that the car miles increase much less rapidly. This is due to the fact that the capacity of the single track on St. James Avenue and Page Boulevard is rapidly being approached, thus materially cutting down the

schedule speed as more cars are added. The single track makes it necessary to run out extra cars considerably in advance of the time when they are required, the dead waiting time being represented by car hours with no corresponding productive car miles.

The daily variation chart (Supplement sheet 4-W) shows the large increase in car miles and more particularly in car hours, due to the addition of the Westinghouse extras on six days of the week. It also shows that although there is an increase of about 75% in receipts per car mile, weekday over Sunday, the receipts per car hour are very little greater on week days than on Sunday, due to the slower speed and waiting time, as noted above.

The maximum load charts (Supplement sheets 4-FN and 4-FS) show the very large number of extra trips run on this line during the morning and evening rush hours, as well as the large overloads, in many cases greater than the comfortable standing capacity, which are carried by these cars.

The characteristic curves (Supplement sheets 4-LNA-a to 4-LSE-b, inc.) also bring out the very heavy loads carried on this route during the morning and evening rush hours. These loads are at a maximum between Walnut and State Streets and Hendeeville on Page Boulevard, but are greater than they should be throughout the whole section between Main Street and the Westinghouse works, the morning outbound rush characteristic, 4-LSA, showing more than 1900 passengers alighting at the Westinghouse works on trips leaving Main Street prior to 8:30 a. m. 450 of these passengers boarded these cars at Main and Carew Streets, 500 at State and Main Streets, about 200 at Walnut and State Streets, and another 200 at the junction of State Street and St. James Avenue. The others were taken on at various points en route.

Service to and from the Westinghouse works in East Spring field probably includes one of the worst problems with which the railway company has to deal at the present time. As noted above, track and car facilities are at present inadequate to care for the large amount of travel to and from this point during the rush hours. The problem is purely that of rush hour handling of traffic, which means that any investment in track

installed and equipment used in this service must receive its return in a very few and concentrated hours. Nevertheless, it will be necessary, in order to satisfactorily handle the situation, for the railway company to make a considerable additional investment. Service to East Springfield could probably best be given over an entirely new route through Carew Street and some private right of way to the junction of St. James Avenue and Page Boulevard, thence along Page Boulevard to the junction with the present tracks. This, however, would involve the construction of 2.6 miles of track, which, to insure the most economical operation, would have to be double track, and would cost approximately $90,000. If assured of the permanence of this traffic, such investment would probably be warranted. As an immediate measure, additional double track should be constructed along St. James Avenue and Page Boulevard where such streets have at present only one track. Considering the fact that a large part of the Westinghouse traffic originates north of Lyman Street, it is further suggested that mileage and time might be saved by running part of the Westinghouse extras via Lyman and Worthington Streets to St. James Avenue. Due to the fact that Worthington Street is single track and has heavy grades, nothing but an actual trial will show how much of this traffic can be so diverted, and in any event, conditions will not be greatly improved by such change unless St. James Avenue and Page Boulevard are double tracked for the entire distance.

Track and car congestion would be considerably relieved also if larger cars could be used as extras on this route, and as new equipment is purchased, this should be kept in mind. If the permanence of this traffic were assured, the company might wisely purchase some large lightweight trailer equipment and install the necessary trackage arrangement in East Springfield for the turning of trailer trains.

There is not much question but that a large amount of revenue is lost by missing fares in the heavily loaded cars on this route during morning and evening rush hours. Much of this could be regained by the operation of prepayment equipment on this route, even with the small cars now used. Such larger equipment, either motor or trailer, as may be purchased for use here, should certainly be operated on the prepayment plan.

Hancock Street—Feeding Hills, Route 5

This route extends from Hickory Street through Walnut, Hancock, State, Main, Plainfield and West Streets, across North End Bridge, through Park, Baldwin and River Streets, across Agawam Bridge, through Mittineague Avenue, Maple Street and Springfield Street to Feeding Hills. During January and February, 1916, the eastern terminal was the Water Shops instead of Hickory Street.

The monthly variation chart (Supplement sheet 5M) and the daily variation chart (Supplement sheet 5-W) show consistently even characteristics for this route except for the normal increase on Saturday.

The maximum load charts (Supplement sheets 5-FN and 5-FS) show few trips with more than comfortable standing capacity except where the headway has been modified by trips omitted or serious delays. Judging by the operation on the day of the traffic survey, such omitted trips and delays are of very frequent occurrence on this route. The normal headway of three cars per hour is certainly all that is warranted by the travel on this route, as shown by the survey, especially on the Feeding Hills end where it might, with economy, be still further reduced to two cars per hour during the normal hours. With a spacing between cars of either the present 20-minute or proposed 30-minute, however, the line, in order to give reasonably satisfactory service, should be operated with much more regularity than at present seems to be the case. An analysis of the delays seems to indicate that they may be caused mostly by the long single track section on Hancock Street and the terminal run out Hickory Street. It is possible that in order to make the service more regular on the Feeding Hills end, this part of the route should be divorced from the Hancock Street end and operated independently by looping around Main and Dwight Streets or connected up with some other city route where there are less possibilities of delays.

The characteristic curves (Supplement sheets 5-LNA-a to 5-LSE-b, inc.) show an exceedingly small load factor for the line as a whole, the only heavy travel being between Main Street in Springfield and the Agawam Bridge in West Springfield during the evening rush hour and also between Main and

Hancock Streets during the evening rush hour. Only a few more than 100 passengers were handled on Hickory Street, including travel in both directions, during the entire day of the traffic survey, and it seems doubtful whether any service at all is necessary on that portion of this route. Some of the car miles and car hours saved by the proposed reduction in headway to Feeding Hills might possibly be used to advantage during the rush hours between West Springfield and East State Street.

Wilbraham Road—Brightwood, Route 6

This route extends from the eastern terminal of the track on Wilbraham Road, through State, Main and North Main Streets to the Chicopee line, and has been so operated since April, 1916.

The monthly variation chart (Supplement sheet 6-M) and the daily variation chart (Supplement sheet 6-W) show fairly regular and consistent operation.

The maximum load charts (Supplement sheets 6-FN and 6-FS) show few trips when the comfortable standing capacity was exceeded. Two such trips occur at 6:50 and 7:50 a. m. eastbound on State Street. The load on these two trips is probably due to travel to Winchester Square and might be taken care of by additional rush hour trips, as recommended in discussing route 5. The northbound load at 5:40 p. m., shown as in excess of the comfortable standing capacity, indicates the desirability of increased northbound service in North Main Street during the evening rush.

The characteristic curves (Supplement sheets 6-LNA to 6-LSE, inc.) show the riding to be fairly well distributed throughout the lines with the exception of somewhat heavier loading on the State Street end.

Catherine—Worthington Streets, Route 7

This route extends from Princeton and Bay Streets, through Bay, Catherine, State, Main, Lyman, Chestnut, Worthington and Princeton Streets to the point of beginning, the return trip being made around the loop thus formed but in the reverse direction, and has been so operating since March, 1916.

The monthly variation chart (Supplement sheet 7-M) and the daily variation chart (Supplement sheet 7-W) show fairly regular and consistent operation throughout the year and week.

The maximum charts (Supplement sheets 7-FN and 7-FS) show no loads in excess of the comfortable standing capacity except two out Worthington Street, one at 5:25 and the other at 6:05 p. m. In both cases irregular headway had produced an extraordinarily long interval ahead of these trips, and the charts show that had an even headway been maintained, these two excessive loads would not have existed. For some reason, on the day of the count only two trips were made out Worthington Street between the trip at 5:05 and the one at 6:05 p. m. where three should have been made according to the schedule. Data shown by these sheets indicate that the headway on this route might well be reduced to three cars per hour after 8 p. m. and possibly between 9 a. m. and noon.

The characteristic curves (Supplement sheets 7-LNA to 7-LSE, inc.) show fairly even and consistent loading of cars on this route with the heavier inbound morning traffic and outbound evening traffic that is to be expected.

State Street—West Springfield, Route 8

This route extends from Pine Point, via State, Main, Plainfield and West Streets, over the North End Bridge and through West Springfield via Main and New Bridge Streets to the Agawam Bridge, and has been so operating since November, 1916. Between April and November, 1916, the eastern terminal was about 1½ miles further east at Berkshire and Harvey Streets.

The monthly variation chart (Supplement sheet 8-M) shows the increases in the number of car miles and car hours operated during the summer of 1916, which were not warranted by the total receipts, and resulted in a falling off both of the receipts per car mile and per car hour.

The characteristic curves (Supplement sheets 8-LNA to 8-LSE, inc.) show by far the greater amount of travel on this route to be on the State Street end, and these sheets considered in connection with the maximum load charts (Supplement sheets 8-FN and 8-FS) clearly indicate that a 20-minute

headway, at least during the normal hours, is ample for the West Springfield section. Heavy maximum loads between 5 and 6 p. m. further indicate the desirability of some additional rush hour service on State Street either by this or some other general route.

The time of the traffic survey did not include any period of special activity at the Eastern States Exposition Grounds. It will, of course, be necessary to provide a great amount of additional service on this route whenever there are special attractions at that point. Assuming that the new Connecticut River bridge will have its western terminus on Bridge Street, West Springfield, such travel to and from the Eastern States Exposition Grounds must be cared for either by double tracking the route on New Bridge Street, or by a loop operation by way of North End Bridge and the new bridge. The latter will require a much greater mileage, but a determination as to whether or not a considerable investment should be put into double track on New Bridge Street will depend on the probable amount and frequency of increased travel due to the Exposition Grounds.

Indian Orchard and Ludlow, Route 9

This route operates inbound via Dwight and Lyman Streets, and outbound from the corner of Dwight and Lyman via Main, State and Berkshire Streets to Main Street, Indian Orchard, and via Ludlow Bridge to Ludlow. The route was operated as thus described throughout 1916 and up until March 18, 1917, when (since the traffic survey) the Springfield terminal has been made Court Square.

As shown by the monthly variation chart (Supplement sheet 9-M), the number of car miles and car hours operated closely followed the total receipts during the year 1916.

As shown by the daily variation chart (Supplement sheet 9-W), the car miles and car hours are practically uniform throughout the days Monday to Friday, inclusive. As shown by this chart, the receipts fall off on Monday, and it is possible that the service rendered on Monday might be decreased correspondingly. This chart also shows an increase in service given on Saturday to meet the increased business of that day.

As shown by the characteristic curves (Supplement sheets

9-LNA-a to 9-LSE-b, inc.) this distinctively suburban route cares for a great deal of through riding, particularly between Indian Orchard and Springfield, although there is a considerable amount of local business between Ludlow and Indian Orchard, where many passengers are transferred to and from Bircham Bend line during the morning and evening rush hours. The characteristic curves show the wisdom of the move on March 18 which brought the Springfield terminal to Court Sq. The characteristic curves show a total of several thousand passengers carried during the day of the count, the average length of ride being nearly four miles plus whatever distance was travelled on transfers issued by this line or by passengers of other lines transferring to this line.

The maximum load charts (Supplement sheets 9-FN and 9-FS) show four inbound trips before 8 a. m., the loads on which were greater than comfortable standing capacity. One other trip, with a total of 90 passengers, is shown arriving at State and Dwight Streets at 4:50 p. m., this, however, being preceded and followed by several trips during which the seating capacity was never approached. Outbound, three trips are shown between 6 and about 7 a. m. when the comfortable standing capacity was exceeded, and also some half dozen trips between 4:30 and 6:30 p. m. when such was the case. The average of the whole number of trips in any 30-minute period, however, will show a loading within the comfortable standing capacity, and it is doubtful whether the company can afford to provide any additional service on this line where the average length of haul is so long, without some additional compensation. Some relief might be had for the outbound rush hour trips by running these cars express as far as Pine Point. The characteristic curves indicate the inadvisability of running all of the four regular cars per hour through to Ludlow, and it is recommended that at least during normal hours one car each 30 minutes be operated only as far as Ludlow Bridge, leaving the service beyond that point a 30-minute headway.

Springfield—Palmer, Route 10

Within the five-cent fare zone, this route operates on the same streets as route 9 just described, except that its Springfield ter-

minal is and has been Court Square. Route 10 includes not only cars the eastern terminal of which is Palmer but also includes the through cars to Worcester. The long average ride in the first five-cent fare zone, noted in connection with route 9, is in evidence here to a still greater extent, being, as shown by the characteristic curves (Supplement sheets 10-LNA to 10-LSE, inc.), considerably more than five miles and during some parts of the day increasing to over six miles.

Belmont Ave.—Brightwood, Route 13

This route operating from Prescott Street through Belmont Avenue and Locust Street, Main and North Main Streets, to Brightwood, consists entirely of extra cars operating only during rush hours.

Although charts for this route are shown in the supplement as though a separate route, it is really a part of the East Longmeadow route 17, and is discussed elsewhere in this report.

Dickinson Street—Brightwood, Route 14

This route operates from the "X," via Dickinson, Locust, Main and North Main Streets, to the Chicopee line in Brightwood, and had so operated since March, 1916. Since the completion of the traffic survey its northern terminal has been Plainfield Street.

The maximum load charts (Supplement sheets 14-FN and 14-FS) show trips inbound from Dickinson Street somewhat exceeding the comfortable standing capacity during the morning rush hours up to 8:30 a. m. as well as outbound between 5:30 and 6:30 p. m. This should be corrected by the addition of a few extra trips during these periods. No overcrowding is noted at other times of the day, and the overloads as noted appear to exist principally on South Main and Locust Streets, so that the extra service recommended might well terminate at the end of the double track on Locust Street Extension.

Forest Park—Chicopee Falls, Route 15

This route extends from the "X" through Sumner and Ft. Pleasant Avenues, Main and North Main Streets, into Chicopee over Rockrimmon Road, Center and Front Streets to Chicopee

Falls. Some trips terminate at Chicopee Falls Center, others cross the bridge at Sheridan Street, while others continue via the Bircham Bend line to Indian Orchard. Since the traffic survey (on March 18, 1917) the southern terminal of the route was made Court Square.

The maximum loads occur during the morning rush between Springfield and Chicopee Falls outbound, and in the evening rush between Springfield and Chicopee outbound. Many cars during the evening rush are operated on this route only between Main and Carew Streets and Chicopee Falls, the traffic count showing that most of them could have been turned back, with economy, at Chicopee. On account of many cars from Chicopee and Chicopee Falls being turned back and omitting the trip south of Main and State Streets, the evening rush curve shows considerable overloading south of this point for the cars which did make the trip. This shows the necessity for the South Main Street service which was taken off by the change on March 18, and as recommended elsewhere in this report, this should again be increased during the rush hour.

Plainfield St —Forest Park, Route 16

This route operates from White Street and Sumner Avenue, through Sumner and Ft. Pleasant Avenues, Main and Plainfield Streets, to Wason Avenue, and has so operated since March, 1916. Since March 18, 1917, the southern terminal of the Plainfield Street route has been Dickinson Street, and the northern terminal of the Sumner Avenue route has been Brightwood.

As may be noted from the maximum load charts (Supplement sheets 16-FN and 16-FS), the maximum loads occur northbound during the morning rush and southbound during the evening rush. These maximum loads occur between the downtown section and Sumner Avenue and should be cared for by additional service on South Main Street, as recommended elsewhere. During the normal hours, the maximum loads are well below the seating capacity.

As may be seen on the characteristic curves (Supplement sheets 16-LNA to 16-LSE, inc.) the loads carried by this route north of the downtown section are small and justify the change made on March 18.

East Longmeadow—Mittineague, Route 17

This route extends from East Longmeadow through Belmont Avenue and Main, Plainfield and West Streets, over the North End Bridge and through Park, Elm and Westfield Streets in West Springfield to Haley Street in Mittineague, and has been so operated since March, 1916. On March 18, 1917 (since the traffic survey) the routeing has been changed during the evening rush hour, when during the period between 4:30 and 6 p. m. the cars operate express from Main and Lyman Streets to the "X" via Ft. Pleasant and Sumner Avenues, returning via the same route during that period. Otherwise, the operation is as described above.

A consideration of the characteristic curves (Supplement sheets 17-LNA-a to 17-LSE-b, inc.) shows that during the morning rush the heaviest loads exist between the City Line and the downtown district, returning cars having only light loads. During the evening rush the maximum loads are between the downtown district and the City Line outbound and during this period the inbound cars are very lightly loaded.

The maximum load charts (Supplement sheets 17-FN and 17-FS) show cars inbound from East Longmeadow loaded above the comfortable standing capacity during the morning rush hour, and during that period some additional service might well be furnished from the "X" to the downtown district. This does not necessarily need to come in via Belmont Avenue, but would serve the district around the "X" and between that point and the City Line, if it came in by way of Sumner and Ft. Pleasant Avenues. Outbound, the maximum load chart shows one trip with an excessive standing load. That trip, however, handled that great number of passengers on account of being off schedule, and, as shown on the chart, the car immediately following within five minutes carried only a seated load. Two other trips about 6 p. m. carried more than a comfortable standing load, but the average of all trips during a 30-minute period, including these two trips, does not show more than comfortable standing loads.

The characteristic curves show the Mittineague end of the line to be well cared for by the service rendered. See recommendation on page 71 relative to "one-way" operation through Belmont Avenue during rush hours.

Springfield—Longmeadow, Route 19

This route extends from the state line in Longmeadow through Main Street, Longmeadow, Longhill Street, Ft. Pleasant Avenue and Main Street to the State-Dwight-Lyman Street loop, and has been so operated since March, 1916. Since March 18, 1917, its northern terminal has been Court Square. The service of this route includes the Hartford-East Side route north of the state line.

The characteristic curves (Supplement sheets 19-LNA to 19-LSE, inc.) show the wisdom of terminating this route at Court Square, as the larger portion of the passengers during the day of the traffic survey left the inbound cars at Main and State Streets. It also shows the long average ride by passengers on this route, nearly 4 miles.

The maximum load charts show several inbound morning rush trips with more than comfortable standing capacity, and it is possible that one additional inbound extra should be operated with the first morning trip. Considering the evening rush outbound, the average of trips over 30-minute periods is below the comfortable standing capacity, and no additional service is recommended.

Springfield—Chicopee via Glenwood, Route 22

This route operates between the Main-State-Dwight-Lyman Street loop in Springfield via Chestnut Street and Glenwood through Springfield Street into Front and Exchange Streets, Chicopee. In January and February, 1916, its southern terminal was Longmeadow. Since that time it has been operating as above described.

As shown by the characteristic curves (Supplement sheets 22-LNA to 22-LSE, inc.) the maximum morning and evening rush loads are between Calhoun Park and downtown, with little travel in the reverse direction.

These charts show the possible advisability of cutting off route 1 (Maple-Chestnut Streets) at Calhoun Park or Chestnut and Springfield Streets instead of operating through to Hamburg Street, as at present. These charts also indicate the advisability of reducing the headway on this route north of Hamburg Street to 30 minutes during the non-rush hours.

The maximum load charts show only two southbound trips with more than comfortable standing capacity. Northbound, several trips during the evening rush show heavy loading which might be reduced by some additional service as far north as Hamburg Street during that period.

It is recommended that the routeing of the Springfield end of this line be changed so that inbound cars will proceed south on Chestnut Street to Lyman and Main Streets, thence outbound north on Main, east on Carew and north on Chestnut Streets. The survey does not show the necessity for these cars proceeding south of Lyman. The one-way operation of Chestnut and Carew Streets is discussed elsewhere (page 72).

Springfield—Chicopee Falls, via Liberty Street, Route 23

This route extends from the Main-State-Dwight-Lyman Street loop, through Liberty Street to Chicopee Falls. It has been so operated since April, 1916.

The characteristic curves (Supplement sheets 23-LNA to 23-LSE, inc.) show the morning rush travel to be heavy throughout nearly the entire length of the line outbound, in a somewhat less degree inbound except from Camp Grounds on Carew Street, where it is heavy. The load factor of the line is high throughout the day, while during the evening rush there is heavy travel, especially between the downtown section and Carew Street outbound, with heavy inbound travel throughout the length of the line. Frequent trips throughout the day exceed the seating capacity, and in the morning and evening rush the comfortable standing capacity is exceeded, although, as shown by the maximum load charts (Supplement sheets 23-FN and 23-FS), many heavily loaded trips are immediately preceded or followed by cars with considerably less than seating capacity occupied. The Carew Street Extension suggested in the discussion of route 4 would materially relieve this route and permit much better operation of the large number of extra trips required during the rush hours.

The discussion under route 4, relative to the use of prepayment collection, larger cars and possibly trailers, also applies to this route. In this case construction of a comparatively short piece of track on Broadway Extension in Chicopee Falls would provide a loop for trailer operation.

Springfield—Holyoke, Route 24

This route operates from a terminal at Court Square, Springfield, through Main, Plainfield and West Streets, over the North End Bridge and through Park and Elm Streets, West Springfield, and Riverdale Road to the Holyoke line. The service is all performed by cars which run through to Holyoke, the equipment being furnished by the two companies jointly. During the period of May to December, 1916, the route operated around the Main and Dwight Street loop.

As shown by the characteristic curves (Supplement sheets 24-LNA to 24-LSE, inc.) the heaviest travel is inbound during the morning rush and outbound during the evening rush, the heaviest loads being in the first four miles from Court Square.

As shown by the maximum load charts (Supplement sheets 24-FN and 24-FS) a few trips are operated at more than comfortable standing capacity. Such trips, however, are in all cases immediately followed by other cars with considerably less loads—in most cases, less than the seating capacity. This line is also one of long average rides, approximately four miles, plus whatever transfer travel exists.

Springfield—Westfield, Route 25

This route operates from Court Square, Springfield, through Main and Plainfield Streets, North End Bridge, Westfield Street and Westfield Road to Park Square, Westfield, the limit of the first five-cent fare with transfer being at Tatham Hills, about 5½ miles from Court Square.

As shown by the characteristic curves (Supplement sheets 25-LNA-a to 25-LSE-b, inc.) the load factor for the entire line is high, which is the only compensating feature in connection with the long average ride in the first five-cent fare zone.

The maximum load charts (Supplement sheets 25-FN and 25-FS) show few trips with more than comfortable standing capacity, such trips being due to the unusual irregularity of the service on the day of the traffic count, caused by drifting snow of the previous day's storm. Such conditions are abnormal, and the maximum loads and irregularity shown by the charts do not exist usually. It is possible, however, that about two additional trips should be run between Westfield

and Springfield between 6:30 and 7:30 a. m., in effect reducing the headway from the present 15-minute to a 10-minute during that period.

Springfield, Agawam and Hartford West Side, Route 26

This route operates from Court Square through Main and Plainfield Streets and North End Bridge, Park and River Streets, West Springfield and through Agawam to the state line, a distance of about 7¾ miles.

As shown by the maximum load charts (Supplement sheets 26-FN and 26-FS) few trips approach one-half the seating capacity of the cars, and only one trip approaches the comfortable standing capacity. Such loads as do exist in excess of the seating capacity extend only to the Agawam Bridge and the additional rush hour service recommended elsewhere would care for such demands.

The business of this line originating south of the state line and through Agawam does not warrant more than hourly service, especially when the small load factor and very long average ride of four to five miles (the longest in the division) are considered.

One-Way Operation on Belmont Avenue

A considerable amount of the irregularity of rush hour service on South Main Street is due to the difficulty of getting cars through the section of single track about one-half mile in length on Belmont Avenue between Marengo and Oakland Streets. This section of Belmont Avenue is paralleled at a distance of not much more than a quarter of a mile by Dickinson Street to the north and Sumner Avenue to the south. The street is so narrow as to preclude the possibility of laying a double track. For this reason, it is suggested that during the morning rush hours Belmont Avenue be operated as a one-way route inbound from the "X," outbound cars during this period using Ft. Pleasant and Sumner Avenues. During the evening rush hours, it is recommended that Belmont Avenue be operated as a one-way street outbound, the returning inbound cars using the Sumner and Ft. Pleasant Avenue route. During both of these periods of one-way operation,

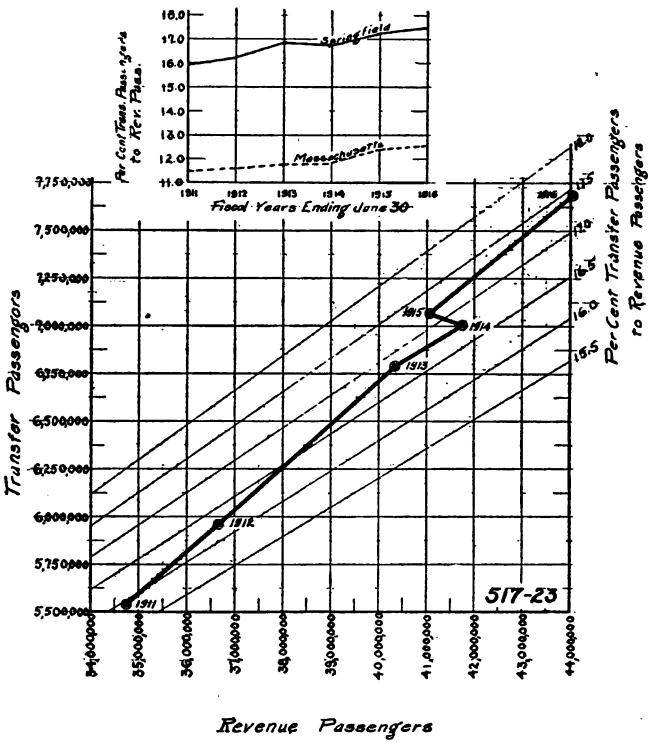
some service could be given in both directions out as far as the end of the double track near Marengo Street. From this point on to the "X," the line is closely paralleled by the Dickinson line with numerous cross-sectioning streets, so that the small number of passengers in this territory who wish to travel in the opposing direction will be subject to but a short additional walk. That the number of passengers who will be subject to such additional walk by such operation is small may be seen by reference to the load curves for outbound morning rush hours and inbound evening rush hours on routes 13 and 17, these load curves being shown as Supplement sheets 13-LSA, 17-LSA, 13-LND and 17-LND.

One-Way Operation on Chestnut and Carew Streets

Until such time as it may be found necessary to construct a new double track on North Street, the operation of Chestnut Street cars, including the Chicopee via Glenwood cars, can be greatly improved by the operation of the single track on Chestnut Street, between Carew and Liberty Streets, as a one-way track southbound, together with the operation of the single track on Carew Street, between Main and Chestnut Streets, as a one-way track eastbound. All Chestnut Street and Chicopee via Glenwood cars should then operate inbound south on Chestnut, west on Lyman, north on Main and east on Carew, thence returning outbound north on Chestnut Street. During non-rush hours, cars on these routes might be operated to State Street by proceeding south on Dwight, west on State and north on Main, instead of running through to Main Street on Lyman, but during the rush hours they should not proceed south of Lyman Street. Such operation will not only tend to reduce congestion on Main Street, but will entirely relieve cars of these routes from passing through the worst part of that congestion and will avoid the delays due to two-way operation of single track south of Carew Street.

Suggested Changes in the Transfer System

Chart No. 517-23, below, shows the number of revenue passengers and the number of passengers using transfers for the years 1911 to 1916, inclusive, and also shows by reference to the diagonal lines, the number of transfer passengers expressed as a per cent of the revenue passengers for these years. These figures are for the entire company, all



divisions. The small insert chart shows a comparison between the per cent of transfer passengers on the Springfield system and those for the rest of the state excluding Boston. It will be noted that the per cent of transfer passengers in Springfield is at present nearly 17.5%, having increased from less than 16% in 1911. During the same period, the use of transfers in the rest of the state has varied between a minimum of about 11½% in 1911 to a maximum of slightly more than

12½% in 1916. Not only has the use of transfers on the Springfield system been much greater than in the rest of the state, but it has increased at a more rapid rate during the period considered.

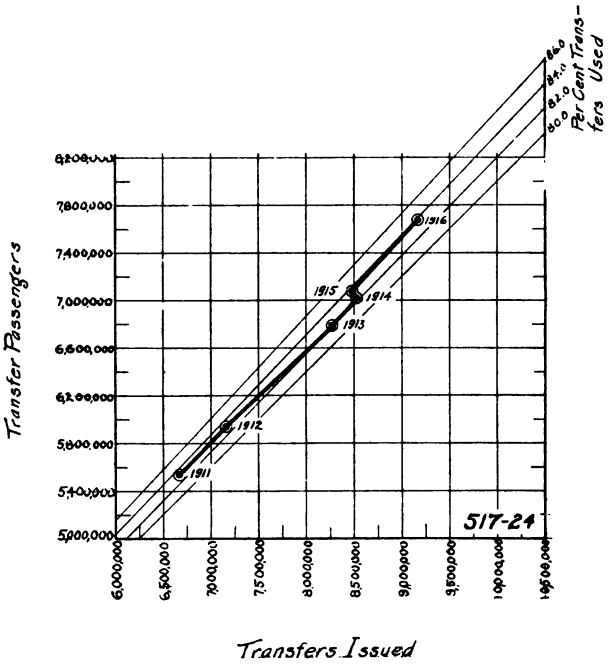


Chart No. 517-24, above, shows the number of transfers issued and the number of transfers used on the lines of the Springfield Street Railway during the years 1911 to 1916, inclusive, and shows only 82 to 84% of transfers issued being used.

The above would seem to indicate the possibility of misuse of transfers. With the present form of transfer, the privilege may quite easily be misused, either with or without the co-operation of the issuing or receiving conductor. This is largely due to the fact that one form of transfer is used for all lines in the city. Good practice demands that a separate form of transfer be used for each route and, preferably, a separate form for each direction on each route. A further protection against misuse consists in using a color scheme whereby the

transfers issued on cars bound in the same general direction are distinguished by being printed on various colors of paper.

A considerable reform should also be made in the requirements that the time be more accurately punched and that transfers be refused after a certain definite short time interval, allowing for use only on the first car of the receiving line.

That there is a considerable slackness in the use of the present transfer system is shown by the fact that on the combined day of the traffic survey nearly 8% of the transfers collected were improperly issued by conductors, in spite of the precautionary instructions mentioned on page 30. No definite idea can be formed of the number of transfers improperly used by passengers, such as the evasion of a fare by the use of the transfer as a stop-over privilege or by other more or less obvious methods. However, it may be said that in a neighboring city where a system similar to the present Springfield one was in effect, a change to a better form of transfer and a more rigid enforcement of the transfer regulations resulted in a net decrease of about 15% of the transfer passengers. Such a decrease applied to the approximately 8,000,000 annual transfer passengers of the Springfield Street Railway would result in a reduction of the number of transfer passengers to the extent of about 1,200,000 annually. If only one-half of these passengers were required to pay the five-cent fare which would be required in lieu of the improperly used transfer, it may be estimated that the revenue lost to the company through improperly used transfers amounts to some $30,000 per year. This is no doubt a very low estimate.

President Brush of the Boston Elevated Railway recently stated before a legislative committee that at one station where that company handles over 40,000 transfers a day, careful checks over a period of several months indicated a loss to the company of about $60,000 a year at that one station.

Obviously, it is not possible to run cars from every piece of track in Springfield to every other piece of track to provide a continuous ride from any portion of the city to any other portion of the five-cent zone. It should be realized that the transfer is simply a method of providing such a through ride for one fare with the change of cars which is required to provide frequent service. The transfer is not, as considered by many, a device to enable a round trip ride to be made for one fare, neither is it a stop-over privilege. This should be realized by the patrons of the company, who will then see no injustice in an improved system of transfers and more rigid enforcement of better rules designed to eliminate round trip riding and stop-overs for a single fare.

Spacing of White Pole Stopping Places

Track Section	Length in Feet	Total Stopping Places	Average Spacing Feet
Main St., Carew to Mill	10017	71	282
Ft. Pleasant Av., Mill St. to Sumner Av	2823	16	353
Sumner Av., Longhill to White Sts	7556	44	343
White & Allen Sts., Sumner Av. to Water Shops	5394	32	337
Hickory St., Walnut St. to End of Line	1800	4	900
Longhill St., etc., Sumner Av. to State Line	23068	104	443
Belmont Av., Mill St. to E. Longmeadow	21075	102	413
Locust & Dickinson, Mill St. to "X"	6686	33	405
State St., Mill St. to Berkshire Av	16044	96	334
Berkshire Av., State St. to Main St., Ind. Or	17308	73	474
Main St., Ind. Or., Oak St. to Wilbraham Line	5471	30	365
Ludlow Ext., Bridge to End of Line	4829	24	402
Bircham Bend, Oak & Main, Ind. Or., to Chic. Falls	22945	52	882
Wilbraham Rd., State Street to End of Line	5980	45	266
Maple & Central Sts., State St. to Water Shops	6435	39	330
Walnut St., State St. to Water Shops	5325	31	343
Hancock St., State to Walnut Sts	3268	20	327
St. James Av. & Page Blvd., State to East St. Ext.	13781	62	444
East St. Ext., Page Blvd. to Broadway, Chic. Falls	9200	19	968
King, Eastern Av., etc., Walnut St. to End of Line	4330	24	361
Worthington St., Chestnut St. to St. James Av	6493	36	359
Liberty St., Chestnut St. to Broadway	12433	72	345
Broadway, Liberty St. to East St.	6339	19	667
Plainfield St., Carew St. to Wason Av	8538	54	316
Catherine St., State St. to St. James Av	4345	28	310
Chestnut St., Worthington St. to Priv. rt. of way	11579	63	367
Springfield St., priv. rt. of way to Front St., Chic	6032	38	317
Lyman St., Main to Chestnut Sts	1349	10	270
Dwight St., Lyman to State Sts	2442	18	271
Carew St., Main to Chestnut Sts	1745	8	436
North Main St., Carew St. to City Line	7177	46	312
Rockrimmon Rd. & Center St., City Line to Front	8273	32	511
Exchange St., Center St. to End of Line	2396	16	299
Front St., Center to Grove Sts	7153	44	325
Grove St., Front to Main Sts	2012	7	573
Church St., Grove to Main Sts	1503	9	334
Main St., Grove St. to Main St., Chic. Falls	745	5	298
Court & Belcher Sts., East to Church Sts	714	3	476
West St., Plainfield St. to Bridge St	1854	5	742
Park St., Bridge to Baldwin Sts	4421	20	442
Elm St. & Riverdale Rd., Park St. to Holyoke Line	21853	97	554
Westfield Rd, Elm St. to Fare Limit	15370	66	466
Mittineague, Church St. to End of Line	1230	8	307
Main St. W. Spfld., Park to Bridge Sts	6152	45	273
Bridge St. W. Spfld., Main St. to Agawam Bridge	8250	44	375
Agawam Rd., Agawam Bridge to State Line	23029	108	426
Mittineague Av., Agawam Br. to Maple & Bridge Sts.	6261	36	348
Maple St. & Feeding Hills Rd., Bridge St. to End	23116	68	680
River & Baldwin Sts., Agawam Br. to Park St	4577	19	482
Total Trackage	400716	1945	412

Spacing of White Pole Stopping Places

The table on the opposite page shows the spacing of white pole stopping places for the various track sections comprising the Springfield division and shows an average spacing between white poles of 412 feet, this including all suburban trackage such as between Chicopee Falls and Ludlow, West Springfield and Holyoke line, Agawam, Longmeadow, etc. Several sections show an average spacing of less than 300 feet, even for comparatively long stretches. For instance, on Wilbraham Road between State Street and the end of the line, a distance of considerably more than one mile, the inner end of which is 1½ miles from Main Street, the white pole spacing averages only 266 feet. On South Main Street in Springfield, over a distance of nearly two miles, the spacing averages only 282 feet.. On Exchange Street from Center Street to the end of the line, a distance of one-half mile, the spacing averages only 299 feet. On Main Street in West Springfield between Park and Bridge Streets, a distance of considerably more than one mile, the spacing averages only 273 feet.

A general observation of the Springfield situation in this respect indicates that the spacing between white poles is considerably too short. Mr. B. J. Arnold of Chicago makes the following remarks on this subject in his 1916 report on the Rochester lines of the New York State Railways, which apply so directly to the Springfield situation that they are quoted verbatim.

"It is unquestionably a convenience to individuals to have cars stop immediately in front of their residences, but the effect of too frequent stops upon speed and headway regularity is a decided inconvenience to all passengers using the line. The elimination of unnecessary stops is largely a matter of public co-operation, as the railway company would undoubtedly be glad to readjust stopping places in the interest of better operating conditions. * * * * In residence districts, a stop spacing of 400 to 500 feet is reasonable, if applicable to existing block lengths. Where blocks are very short or streets offset, it is not necessary to stop at every intersection. In the business district, however, stopping places are indicated largely by traffic conditions."

It is recommended that a definite study be made of the location of white pole stopping places throughout the Springfield division to the end that the white poles may be relocated in such a manner, with due regard to street intersections, that the spacing throughout the settled residence districts be made to conform as closely as possible to a 400 ft. minimum and a 500 to 600 ft. maximum. Together with the stopping places for the business district, as recommended elsewhere in this report, and the much longer average spacing which can be maintained along the sparsely settled sections of track, it is believed that such a campaign will result in the elimination of 20 to 25 per cent of the total number of stopping places, with a consequent increase in average distance between stopping places to more than 500 ft.

This should result in a very beneficial increase in schedule speed, with a consequent improvement in regularity of headway—an all-around improvement in service.

Vehicular Traffic in Main Street

The Jitney Problem

The table on the following page shows an actual count of all vehicles passing along Main Street both north and south bound during the nine hours between 11 a. m. and 8 p. m. on Wednesday, March 21, 1917. The count was taken at two places, as shown by the table, between State Street and Court Square and between Bridge and Worthington Streets. In the tabulation the results are shown by hours, and in various columns are shown the number of street cars, jitneys, other automobiles, horse-drawn vehicles, and the totals both excluding and including street cars. It will be noted that the heaviest traffic occurred northbound between Bridge and Worthington Streets where, during the nine hours, out of a total of 4351 vehicles, 16% were street cars, 46% were jitneys, 32% were other automobiles, and less than 6% were horse-drawn vehicles. In their heaviest hour, between 6 and 7 p. m., the street cars were 23½% of the total. In their heaviest hour, between 5 and 6 p. m., the jitneys were 55½% of the total. In their heaviest hour, between 2 and 3 p. m., the "other automobiles" were 49% of the total. In their heaviest hour, between 11 a. m. and 12 o'clock noon, the horse-drawn vehicles were 10½% of the total.

This table shows simply the number of vehicles and not the number of seats. In this way, it is not a proper comparison of transportation service rendered to the public by the various sorts of vehicles. The average seating capacity of the street cars is about 40, while the average seating capacity of the automobiles, including jitneys, is only about four, excluding the operator of the machine. Applying this ratio of 10 to 1, it will be seen that on the typical day cited and during the nine hours observed, the street cars furnished nearly 60% of the total transportation facilities northbound between Bridge and Worthington Streets, with only 13½% of the total number of vehicles. Allowing for the fact that the street car occupies perhaps double the area as that of the automobile, it will still be seen that the street car is by far the most economical in its use of street area per passenger carried.

Vehicular Traffic in Main Street, Springfield

Wednesday, March 21, 1917

Time	Street Cars	Jitneys	Other Autos	Teams	Total	
					Exc. Cars	Inc. Cars
Between State and Sanford Streets—Northbound						
11 a.m.—noon	52	118	150	33	301	353
noon —1 p.m.	52	189	149	15	353	405
1 p.m.—2 "	54	111	112	19	242	296
2 " —3 "	54	72	250	30	352	406
3 " —4 "	58	50	172	21	243	301
4 " —5 "	67	114	181	17	312	379
5 " —6 "	79	162	140	27	329	408
6 " —7 "	114	170	95	10	275	389
7 " —8 "	68	190	165	4	359	427
Total 9 hours	598	1176	1414	176	2766	3364
Between Bridge and Worthington Streets—Northbound						
11 a.m.—noon	60	210	170	45	425	485
noon —1 p.m.	60	297	145	19	461	521
1 p.m.—2 "	64	231	162	25	418	482
2 " —3 "	64	124	220	41	385	449
3 " —4 "	68	93	166	35	294	362
4 " —5 "	77	166	180	32	378	455
5 " —6 "	90	312	132	28	472	562
6 " —7 "	124	290	96	14	400	524
7 " —8 "	79	290	127	15	432	511
Total 9 hours	686	2013	1398	254	3665	4351
Between Elm and State Streets—Southbound						
11 a.m.—noon	60	128	190	3	321	381
noon —1 p.m.	61	191	160	9	360	421
1 p.m.—2 "	62	130	151	14	295	357
2 " —3 "	61	74	203	26	303	364
3 " —4 "	68	54	180	21	255	323
4 " —5 "	108	100	200	23	323	431
5 " —6 "	96	184	210	6	400	496
6 " —7 "	76	180	146	5	331	407
7 " —8 "	66	187	93	0	280	346
Total 9 hours	658	1228	1533	107	2868	3526
Between Worthington and Bridge Streets—Southbound						
11 a.m.—noon	68	202	160	27	389	457
noon —1 p.m.	69	293	135	14	442	511
1 p.m.—2 "	72	231	143	23	397	469
2 " —3 "	71	108	194	33	335	406
3 " —4 "	78	80	187	42	309	387
4 " —5 "	118	153	180	25	358	476
5 " —6 "	107	310	144	7	461	568
6 " —7 "	86	268	113	8	389	475
7 " —8 "	77	274	115	1	390	467
Total 9 hours	746	1919	1371	180	3470	4216

It is probable that at another time of year, during the summer months, the automobiles, other than jitneys, would show a larger per cent of the total than is shown by this table.

This table shows the magnitude to which the jitney business has grown in Springfield. Without doubt, this form of competition has resulted and is resulting in a very large and serious loss of revenue to the street railway company. Furthermore, it is by far the largest contributing factor to the present condition of congestion along Main Street. It is, in fact, the condition which makes the entire difference between the present bad congestion and practically no congestion. This was amply demonstrated during the past winter in the short interval during which practically no jitneys were operated in the city. During those few days it is a fact that with no equipment in service in addition to that on the days preceding and following, the street railway company was able to care for all of the business offered, including that otherwise carried by jitneys, in a far more satisfactory manner than on the days while jitneys are operating. During this period of no jitney competition, headway and schedules were satisfactorily maintained due to the absence of the abnormal traffic interference, this permitting the operation of the service at the speed and frequency at which it was designed, and further resulting in more cars per hour through Main Street during the rush period.

As has been stated, the jitney in common with other vehicles is uneconomical of street space, considering passengers carried per square foot of area occupied, thus largely contributing to congestion of traffic. Further, its accident hazard is high on account of its inherent qualities of running rapidly and quietly and departing from a fixed path at the will of the driver, turning out of side streets and coming from behind other vehicles with confusing quickness. Jitneys are not all driven by men trained to their work and freed from distraction in the performance of it. They require a smooth and substantial street surface and at the same time exercise a destructive action on street paving while making no contribution toward its maintenance. Even with no allowance for interest on investment, depreciation or accident risk, it is evi-

dent that the jitney cannot operate at a profit on a five-cent fare except with a short haul considerably within the limit of the paying haul of the street railway, as discussed elsewhere in this report. It therefore confines its operation to this short haul, with the result that the entire business which it takes from the street railway is only that which is profitable to the street railway company, leaving the long haul passengers to the railway, which passengers it must carry at a loss.

There should be some regulation of this jitney business by the city of Springfield, not only in fairness to the street railway company, but in fairness to the entire city. Jitneys should not be permitted to occupy the large proportion of space in Main Street, as shown by the table on page 80, for the purpose of private profit, without some recompense to the city in the form of a license tax, especially when, as now, congestion has reached the point where the city must, if it continues, spend larger sums of money in providing other arteries for travel. Further, the operators of jitneys should be required to furnish a substantial bond to provide indemnification against the risk of accidents.

The owner of a building could not, with fairness either to himself or to his tenants, allow one portion of it to be occupied by an absolutely responsible tenant who made and paid for his own repairs, and another part of it to be occupied by another tenant who, although engaged in the same business, not only was absolutely irresponsible, but damaging to the building and without any liability for repairs and with the payment of practically no rent for the space occupied. As stated, such a procedure by a landlord would be regarded by all of his neighbors as absolutely foolish and suicidal to his own interests, as well as absolutely unfair to the first-named tenant. Nevertheless, this is the attitude which the city of Springfield is at present adopting towards itself, the street railway company and the jitney operators, in its attitude of non-regulation of the jitney traffic.

Operation on Main Street

Congestion both of street cars and other traffic along Main Street has often been suggested as one of the chief contributing causes of slow, irregular and perhaps inadequate street car operation in Springfield. Familiar situations in the operation through Main Street include the bunching and delay of cars, the stream of moving automobiles occupying nearly all of the space between the standing cars and the second line of automobiles parked at the curb, and the efforts of street car passengers to board or alight from cars safely in the most inadequate space left by the standing and moving automobiles. Main Street is less than 50 feet in width between curbs, at some of the points of greatest congestion.

The scheduled running time of cars on Main Street between Carew and State Streets was formerly 9 minutes, and some years ago the trip was made easily in that time. In May, 1916, the running time between these points was increased to 11 minutes, and that this time is not made easily at present is well illustrated by the table on the following page, which shows the delays through Main Street between Carew and State Streets during the day represented by the traffic survey. In some cases, more than 20 minutes was required for the trip from Carew to State Street.

Out of a total of 2554 trips, 763 required more than the scheduled time, these trips being delayed a total of 2487 minutes, or an average delay of 3¼ minutes per delayed trip. The percentage of trips delayed and the average delay per delayed trip varies somewhat as between different routes, as noted in this table. The large percentage of delayed trips and the great amount of time lost through this section, however, clearly indicate either that the scheduled running time through this section should be increased or that some measure should be taken to reduce the number and amount of delays. An analysis of the causes contributing to this delay seems to indicate that efforts should be made along each of several lines to reduce the delays before any further increase in running time is allowed. The most apparent lines along which a better-

Delays Through Main Street

Between Carew and State Streets

Route No.	Route	Total Trips Observed	Trips Requiring more than Sch. Time	Total Minutes Delayed	Per Cent Trips Delayed	Average Delay Per Delayed Trip
		Northbound Cars				
1	Maple to Brightwood.....	71	34	89½	47.9	2.63
3	King to Chestnut.....	75	16	49½	21.7	3.09
4	St. James Av. to Wason Av.	91	40	197	44.0	4.92
5	Hancock to Feeding Hills...	48	29	28¼	60.4	0.97
6	Wilbraham Rd. to Brightw'd	74	27	56¾	36.5	2.10
7	Catherine to Worthington..	73	7	15	9.6	2.14
8	State to West Springfield...	79	45	151½	57.0	3.37
9	Ludlow to Springfield.....	5	2	7	40.0	3.50
13	Belmont to Brightwood.....	32	13	60½	40.6	4.65
14	Dickinson to Brightwood...	75	28	78	37.3	2.79
15	Forest Park to Chic. Falls..	69	36	186¼	52.2	5.17
16	Forest Park to Plainfield...	76	24	57	31.6	2.37
17	E. Longm'd'w to Mittineague	80	32	103½	40.0	3.24
19-20	Longmeadow to Springfield.	5	4	29	80.0	7.25
22	Sprfld. & Chic. (Glenwood)	66	16	31½	24.2	1.97
23	Sprfld. & Chic. Fls. (Liberty)	87	29	44	33.3	1.52
24	Springfield to Holyoke.....	80	28	114	35.0	4.07
25	Springfield to Westfield....	60	25	104	41.7	4.16
26-27	Sprfld. to Hartford (WS)..	36	36	27½	100.0	0.76
Total	and Average (northbound)	1182	471	1429¾	39.8	3.04
		Southbound Cars				
1	Brightwood to Maple.....	73	12	41½	16.4	3.46
2	Crosstown & Walnut.....	150	15	27½	10.0	1.82
3	Chestnut to King.....	74	20	65½	27.0	3.27
4	Wason Av. to St. James Av.	99	32	102	32.3	3.19
5	Feeding Hills to Hancock..	48	14	52	29.2	3.71
6	Brightw'd to Wilbraham Rd.	73	8	14½	11.0	1.81
7	Worthington to Catherine..	73	21	43½	28.8	2.07
8	West Springfield to State...	79	17	40	21.5	2.35
9	Springfield to Ludlow.....	99	24	55½	24.2	2.31
13	Brightwood to Belmont....	34	14	42	41.2	3.00
14	Brightwood to Dickinson...	75	17	56¼	22.7	3.31
15	Chic. Falls to Forest Park..	82	17	50¼	20 7	2.96
16	Plainfield to Forest Park...	74	20	56¾	27.0	2.84
17	Mittineague to E. Longm'd'w	84	17	56	20.2	3.29
19-20	Springfield to Longmeadow.	78	12	21½	15.4	1.79
24	Holyoke to Springfield.....	80	8	36	10.0	4.50
25	Westfield to Springfield....	61	13	272	21.3	20.92
26-27	Hartford (WS) to Sprfld..	36	11	25	30.5	2.27
Total	and Average (southbound)	1372	292	1057¼	21.3	3.62
Total	and Average—All Cars	2554	763	2487	29.9	3.26

ment in the service may be had are listed as follows, a discussion of each item following the list:

Possible reduction of the number of cars through Main Street.

Reduction in the time required for loading and unloading passengers.

More rapid acceleration and braking.

Improvement in traffic regulations and in the handling of traffic.

Elimination of other unnecessary delays.

Possible Reduction of the Number of Cars Through Main Street

The number of cars passing through Main Street between Court Square and Lyman Street during the hours of 4:30 and 6:30 p. m. on the typical day of the traffic count was 202 northbound and 211 southbound. The southbound car movement was at a maximum of 216 cars during these hours in the portion of Main Street directly in front of Court Square. This car movement, as well as that on all other sections of track in the downtown district, is shown on Chart No. 517-22 facing page 52. As the traffic is not evenly distributed throughout the two hours mentioned, the maximum rush hour will show a daily average of about 125 cars southbound on this section of Main Street, with a somewhat smaller movement northbound. This is again shown by the table on page 80 (Vehicular Traffic on Main Street) and is approaching a density of car movement which may cause congestion, even with an ideal regulation of all street traffic.

If the construction of the proposed new Connecticut River bridge provides for a terminal as far south as Court Square, the Main Street tracks north of that point will be relieved of a considerable amount of the car movement which now enters Main Street at Carew Street via the north end of Bridge and Plainfield Streets. This in itself will be a great relief, but as a further measure, it is recommended that the Worcester, Palmer and Ludlow cars, which enter the city via State Street, be diverted into Dwight Street to a terminal on Dwight Street somewhere near the Union Station, returning by way of the same route. Such terminal might be at a cross-over on Dwight Street

near Lyman, or preferably in a loop consisting of Dwight, Lyman, Chestnut and Worthington Streets, which loop can be constructed by the addition of a few hundred feet of track on Worthington Street and between Dwight and Chestnut.

This recommendation relative to the routeing of Worcester, Palmer and Ludlow cars should be applied during rush hour periods, even though a portion of these cars be routed through Main Street during the non-rush hours.

Definite recommendations cannot be made relative to the routeing of West Side cars, as at this writing, the location of the eastern terminus of the proposed new bridge is not definitely known. Wherever this terminus be located, however, it is recommended that loop tracks be constructed at the eastern terminus of the bridge and entirely west of Main Street, so that West Side cars may be kept entirely away from Main Street.

It is thought that Main Street may also be relieved of some cars by routeing extra cars going to and from the car house "light" by some other street or route. As Chestnut Street has only a single track, this change may be dependent upon the installation of track in North and Carew Streets.

Reduction in Time Required for Loading and Unloading Passengers

Reference to Chart No. 517-21 on page 47 shows that the loading time per passenger in Springfield varies from two to nearly four seconds per passenger. Compared with similar data from other cities, this is high, being nearly double the time required in cities such as St. Louis, St. Paul, Indianapolis, Minneapolis, Milwaukee and Duluth. Much of this delay in loading and unloading passengers in the downtown section is probably due to the large amount of automobile traffic alongside the cars and the lessening of the available space by vehicles standing at the curb, as discussed in a following section.

Patrons of the company might materially reduce the time required at stops if they would habitually conform to the reasonable request to be at the front door when nearing their stop.

A reduction in the loading time would be accomplished by the enforcement of the rule that standing in the rear vestibule is prohibited when there is room inside the car.

"Multiple berth passenger stops" are also recommended for

the Main Street section, as a great deal of time is lost after two or more cars have been stopped at a crossing and the first car is given the signal to proceed, in requiring the second or following cars to make a second passenger stop at the crossing. When more than one car is stopped at a traffic intersection, the one stop should be considered the only passenger stop at that intersection, and all passengers boarding or alighting at that stop should be required to board or alight at the point of first stop, so that when the signal is given to proceed across the crossing, the two or three cars may proceed without the succeeding ones making a second passenger stop. Such "multiple berth" operation will in itself eliminate a considerable amount of the Main Street delays. In order that this may be done successfully, however, automobiles and other vehicle traffic must be regulated to conform.

More Rapid Acceleration and Braking

The rate of acceleration and braking has a considerable effect on the time required for a car to enter and get away from the required stop. If such rates are low, the effect is precisely the same as an increase in the time of stop. Observations seem to indicate that the rates of acceleration and braking approximate one mile per hour per second in Springfield, being especially low in the Main Street section, particularly during rush hours. There seems to be a decided tendency to coast or creep up to a stop, especially if following another car which is stopped at a street intersection. This probably is due to the motorman's idea that by slowly creeping up on the car ahead he can obviate making two stops, one on account of the car ahead and the second to take on and leave passengers. With "multiple berth" operation, the necessity for this will disappear. A campaign of education should be conducted among the motormen for the purpose of increasing their habitual rates of acceleration and braking. In the Main Street section average rates of 1.50 to 1.75 m.p.h.p.s. should be used, and in other parts of the city it should be possible to use average rates of 2 m.p.h.p.s. Such rates, with properly maintained equipment, are not dangerous or uncomfortable to passengers and will result in increased schedule speeds generally, but particularly through the Main Street section.

As the problem of the traffic congestion in Main Street is one which affects not only the operation of the Springfield Street Railway, but also all other vehicles as well as the pedestrians that use Main Street, its relief is a problem not only for the street railway company but for the city of Springfield. Both parties have a part in producing the congestion, and both parties will be benefitted by its relief. The utmost co-operation must therefore be practised between officials of the street railway company and the city and its traffic officers.

In this connection it should be noted that throughout the country there is a growing better recognition of the superior rights on the streets possessed by electric cars. Among the reasons why the cars should have superior rights are the facts that they are the greatest public means of transportation, that they are confined to the definite routes laid out by the track rails, and the more important fact that they carry a larger number of persons per square foot of street occupied than any other kind of vehicle. Although in the past makers of municipal ordinances and judicial decisions governing street traffic often have lost sight of these fundamentals, evidences of a better understanding of them are given by the general rule that automobiles shall not pass a standing car which is discharging or taking on passengers, unless they provide a clearance of six or eight feet, and by the restrictions in many cities on parking automobiles in streets occupied by tracks, especially near the street car stopping places. A most recent evidence of the improving viewpoint of cities toward this problem is shown in the traffic regulations of Oakland, California, lately (1917) issued. These regulations definitely set forth that street cars have the right of way over other vehicles at all intersecting highways not controlled by traffic officers, and that in all places drivers shall not unnecessarily hinder or delay the operation of street cars. Another section of the ordinance prohibits "jay walking" or the cutting of corners by pedestrians.

Traffic regulations should be revised to practically prohibit the parking of automobiles at the curb along Main, Dwight and lower State Streets during rush hours, stops at the curb being limited to those required to load or unload passengers. At no time of the day should parking of automobiles be permitted op-

posite the loading places for street cars, as described below, and during rush hours no automobiles should be permitted to stop opposite such loading places except when stopped by traffic officers. If parking be so limited, it would be possible to require automobiles to maintain a distance of at least eight feet away from the street car rail opposite loading places, thus providing a safety zone in which passengers may safely board and alight from street cars. Such safety zone should be designated either by painting the street surface or erecting stanchions. Some cities go so far as to provide raised platforms in the paving for such safety zone.

Throughout Main Street the loading places for street cars should be at the near side of cross streets. Should a car be standing in the first loading berth next to the cross street at the time of the arrival of a second car, the loading place for the second car should be directly behind the first, and should a third car arrive before the second has left, its loading place should be directly behind the second. The second and third cars should not be required to make a second passenger stop at the same street intersection. It is believed that this will not work any hardship on patrons of the street railway in that they can be assured of safety in the street alongside of the cars by the establishment of the safety zones, as proposed above. Should such "multiple berth" operation be adopted, a proper co-operation with the traffic officers would result in the virtual dispatching of cars along Main Street in groups of two or three instead of irregularly, often singly, as at present. The present fault does not lie entirely with the traffic officers, as oftentimes the second or other succeeding cars are required to make stops for passengers at the street intersection at a time when the officer is ready to signal that they may proceed. By the time passengers have boarded the car and it is ready to proceed, it is necessary for the traffic officer to give right of way to street traffic, thus making greater delay. This would be avoided by "multiple berth" operation and group dispatching by officers.

In this connection it is suggested that the railway company station street officials at the most important cross streets along Main Street during rush hours, which officials might greatly facilitate the movement of cars at such intersections by proper co-operation with the traffic officers.

Elimination of Other Unnecessary Delays

A great many delays which result in the unnecessary delay and bunching of cars on Main Street are incident to the operation of the car house and shops at Carew Street. Such delays as are incident to the switching of operating equipment will be considerably reduced by the removal of the operating car house to the new Hooker Street location. Even then, however, delays will be had on Main Street unless the switching of cars into and out of the car yards be done under the supervision of a decisive official. With the removal of the operating car house to Hooker Street, the shops will still remain at Carew Street, and a considerable amount of switching will be necessary on Main Street at that location. As this will involve only the movement of equipment for repairs, it is entirely possible to so regulate it that it will not interfere with the important movements of Main Street traffic, especially during rush hours. Such regulations should be made and rigidly enforced that would entirely eliminate such causes of delay to Main Street traffic.

A considerable delay is often experienced at Carew Street due to apparent disregard of the importance of changing cars and transaction of business with the starters at that point with the utmost dispatch and with a minimum loss of time. Such disregard of time by operating crews probably is the result of other delays which in the past seemingly have been necessary at that point. With the removal of the operating car house to Hooker Street, however, rules relative to the relief of crews and unnecessary wasting of time in passing the starter's office should be clearly worded so as to impress their importance on the operating forces, and once issued, should be rigidly enforced. A relieving crew should be at the side of the track ready to board the car the instant that it arrives, and no conversation between the relieving and relieved crews which would delay the prompt leaving of the car should be necessary or allowed. Such officials as are necessary to receive verbal communications from passing crews should be on the street, and not an instant's delay should be caused by car crews leaving their cars when passing the operating center.

Regular Scheduling of Cars

If a carrying out of the above recommendations results in cars passing through Main Street on schedule time, satisfactory operation will further demand that the cars be spaced evenly as regards destinations. Timetables should be made out thus evenly spacing cars for various destinations past some central point such as Court Square, and with due regard not only to routes but also to the general section of the city to which cars are bound. For instance, if a 15-minute headway is maintained on each of the three routes through Dickinson Street, Belmont Avenue and Sumner Avenue, these three routes should be evenly spaced outbound at approximately five-minute intervals from Court Square and inbound at approximately five-minute intervals from the "X."

Not only should a fairly even headway be maintained through Main Street, but a due consideration of routes should be had, so that the headway on Main Street south of State, on State Street, on Main Street north of Carew, and other similar portions of the line, will be as nearly as possible uniform, especially during rush hour periods.

Work Completed Under Authorized Improvement Requisitions

January 1, 1913 to March 31, 1917

I/R No.	Description	Amount Expended
1698	Purchase 1 express car	$ 4,960.19
1710	Purchase 6 30'-3½" closed cars	38,092.84
1711	Purchase 9 28' closed cars	47,456.43
1714	Purchase 4 35' semi-convertible cars	33,374.80
1718	Renew special work at 42 points	21,118.49
1727	Renew rail on Walnut St. between King and State, Springfield	10,253.88
1754	Renew track and build 2nd track, No. Main St. to Chicopee Line	7,465.66
1772	Const. 2nd track, St. James Av	8,814.47
1776	Relocate track & build 2nd track, Broadway, Chic. Falls	11,633.21
1800	Renew ties, Pine Point-Chestnut St., Indian Orchard	22,209.59
1815	Track changes between Water & Hill Shops, U. S. Armory	11,530.47
1832	Purchase land at Hooker Street	25,023.75
1835	Const. double track Woodlawn & Lees T. O. Westfield Line	23,068.48
1836	Recon. track Main St. between Bliss & Wilcox, Spfld.	9,892.99
1837	Recon. double track, Plainfield St., Springfield	6,472.44
1868	Purchase 10 convertible cars	39,826.95
1889	Lower running boards on 92 cars	14,746.42
1898	Purchase 10 pairs trucks & electrical equipments	17,426.22
1919	Purchase 32 pairs of trucks	17,719.50
1963	Purchase 15 4-motor equipments	26,915.96
	Miscellaneous requisitions not listed above, as follows:	
	69 Track and paving	117,619.05
	8 Power station	8,243.24
	7 Overhead line, signals, etc	11,015.44
	15 Cars and car equipment	30,645.45
	13 Car houses and shops	9,143.25
	13 Miscellaneous	2,604.53
	TOTAL	$580,365.23

IMPROVEMENTS IN ROAD AND EQUIPMENT

Improvements Completed, 1913 to Date

The table on the opposite page shows some detail of the expenditure of nearly $600,000 which has been made on improvement requisitions authorized since January 1, 1913, and now completed. As may be noted, this includes large expenditures for improvements and additions to tracks, rolling stock, car houses and shops, together with substantial sums expended on power stations and overhead lines.

Improvements Authorized Since 1913, But Not Yet Completed

The table on the following page shows the estimated cost, amounting to nearly $750,000, of various improvements authorized since January 1, 1913, but not fully completed on March 31, 1917. The amount shown, as may be noted, also includes considerable amounts for improvements and extensions of track, new and converted rolling stock and additional feeder copper, etc.

In addition to the above, this list shows the item of more than $230,000 authorized for the construction of the new car house and storage tracks at Hooker Street, which is at present practically completed. These facilities will probably be in use by the company by the time this report is issued, and, as noted elsewhere, the addition of this thoroughly modern and well-equipped car house, together with its conveniently arranged storage tracks, should very greatly facilitate operations and make possible a considerably improved condition of the operating equipment, as complete facilities have been provided for the regular cleaning and inspection of rolling stock and the making of minor repairs.

It will be noted that this tabulation also shows authorization for the purchase and installation of additional shop machinery at Carew Street and changes to the building at that point. Such machinery, when installed in the space released by moving the operating car house to Hooker Street, will provide very greatly increased facilities for car repairs. This should also result in improved service.

Improvement Requisitions Approved and Work Authorized but not Completed

January 1, 1913 to March 31, 1917

I/R No.	Description	Amount Appropriated
1838	Renew special work at 34 points	$26,064.73
1933	Reconst. track, State Street, Catherine to R. R. tracks	9,058.56
1964	East Springfield ext. to Chicopee Falls	24,701.38
1983	Relocate and reconst. tracks, Plainfield and West Streets	16,327.17
1991	Convert 1 14-bench open car to all-year-round car	1,644.40
2017	Const. track Church Street, Chicopee Falls	5,883.75
2030	Convert 9 open cars to prepayment type	15,974.00
2037	Install double running boards on 91 S.T. open cars	8,153.00
2039	Convert 18 open cars to prepayment type	31,116.00
2046	Keystone signs for 52 cars	2,184.00
2047	3-wire system	9,000.00
2053	Convert 24 box cars to prepayment type	18,936.00
2056	2½ blocks of Chapman signals	1,331.19
2059	Install underground conduit, Longhill Street	4,282.98
2065	Const. turnout, Plainfield Street	3,274.85
2066	Ext. double track, Plainfield Street	2,801.46
2067	Const. 2nd track and relocate track, Park, River and Baldwin Streets, West Springfield	8,095.24
2069	Relocate turnout, Page Boulevard	2,662.45
2074	Const. Turnout, Page Boulevard near Hendee Works	5,524.71
2077	Purchase 10 conv. prepayment cars	64,740.00
2078	Purchase 1 express car	6,195.00
2097	Reconst. track, Liberty Street	3,787.65
2100	Const. turnout, Four Corners, East Longmeadow	2,009.07
2104	Renew special work, 30 points	19,583.37
2105	Reconst. track, Chestnut Street	5,966.04
2114	Reconst. track, Palmer line	3,702.26
2118	Siding, West Street, Springfield	1,762.11
2122	Const. 2nd track and relocate present track, St. James Avenue	17,257.83
2123	Additional feeders, West Springfield	12,305.00
2130	Double tracks, storage and loop tracks, West Springfield	18,745.34
2132	Extend and renew tracks, Chicopee, West and Center Streets	13,922.56
2137	Relocate, reconst. and const. track, Longhill Street	6,773.49
2140	Reconst. double track, Westfield Street, Holyoke line	8,925.25
2156	Const. new carhouse and storage tracks	232,670.98
2164	Ext. of track, Broadway, Chicopee Falls	9,220.75
2168	Const. of garage, Bond Street	9,531.40
2189	Purchase and install additional machinery, Carew Street	9,137.28
2192	Renewal of special work at 20 points	9,576.55
2198	Carew Street extension	48,823.06
	Branch-off at Memorial Square, Springfield	9,142.45
	Estimate of changes to Red Brick Car Barn, Springfield	2,620.00
	28 additional requisitions, not listed above	20,326.31
	TOTAL	$733,739.62

This table shows further provision for the expenditure of a considerable sum for additional feeders in West Springfield, together with another substantial item for "3-wire system." These expenditures have been shown to be necessary through the co-operation of the engineers of the U. S. Bureau of Standards, who have recently conducted an extensive investigation of the electrolysis situation in the city of Springfield. Their recommendations, which are being followed by the railway company, contemplate the installation of the so-called "three-wire system" in the distribution of energy from the power station to the various sections of the operating trolley wire. This system has been tried out on a small scale by a few foreign railways, and in one case on a small scale by an electric railway on the Pacific Coast. With reference to this system, a preliminary (and yet unpublished) report of the American Committee on Electrolysis (on which the U. S. Bureau of Standards, the American Institute of Electrical Engineers, and other national engineering organizations are represented) contains the following statement:

"Until very recently it was thought that three-wire systems contained certain serious inherent disadvantages. It was felt that the complications in machinery, difficulties in successfully insulating trolleys of different polarities, difficulties in equalizing the load between different sections, and, further, the necessity for the installation of larger generating units to compensate for the difficulties in balancing than were required with the single-trolley grounded system, were so great as to preclude the consideration of the three-wire system for electrolysis mitigating purposes. Recently, however, interest in this system has been renewed, and at least some of the difficulties successfully overcome, with the result that at the present time there are in operation or being installed two sectionalized three-wire systems—one in operation in the Hollywood district of Los Angeles, Cal., and the other in process of installation in West Springfield, Mass."

After a very thorough study of the matter, the engineers and officials of the Springfield Street Railway have decided that the adoption of the three-wire system in the central distribution district, even though it involves substantial expenditures, is advisable in view of the much larger degree of protection for underground piping systems against the danger of electrolysis by

stray currents from the electric railway which it appears will be afforded by this system, as compared with the methods ordinarily followed by other electric railways. Such expenditures will not be limited to the amounts now appropriated and listed in the table on page 94, but must be followed by others in the near future, in order to fully obtain the benefits of the proposed system.

The New Power Contract

A contract has recently been made with the Turners Falls Power and Electric Company whereby that company, as soon as the necessary construction and installation can be completed, will take over the present Margaret Street power station of the railway company and operate it as its substation. Power will be supplied to the railway company from the Margaret Street substation, as well as from substations in Westfield, Agawam, Chicopee and Indian Orchard. The contract also provides for the installation, when necessary, of an additional substation in the neighborhood of Main and Carew Streets, and further provides for the installation of additional substations at other points whenever the growth of the railway business makes such additions necessary.

The contract is very broad in its provisions. Briefly stated, it provides for furnishing whatever amounts of power may be necessary for the proper operation of the street railway system. This power contract was finally made after long and careful consideration by the engineers and officials of both the railway and the power companies, of the past, present and probable future costs of power to the railway company, not only under such a contract as was finally made, but under an assumption that the company make the very large investment necessary to manufacture its own power supply. Due consideration has been given, not only to the matter of costs, but to that of satisfactory and reliable operation, and a final decision in the matter was made only after consultation with several competent railway power engineers outside the Springfield company's organization. It is believed that the contract just made will result in a reliable and satisfactory power supply at a cost not greater than that which would be incurred by the manufacture

of its own power by the railway company, due allowance being made for fixed charges on the additional investment of approximately $1,500,000 which would have to be incurred in the immediate future and an ultimate expenditure of more than $2,000,000 if the railway continued to manufacture its own power.

Operation under the new contract will begin as soon as delivery can be had on the necessary new machinery which has been purchased by the power company, it being expected that in the meantime the necessary additions to its transmission lines can be completed.

Proposed Track Extensions

At various places elsewhere in this report suggestions have been made as to the advisability of construction of additional track. Approximate estimates of the cost of such extensions, together with others which may be necessary to care for traffic requirements in the near future, are as follows:

Track construction on Broadway Extension in Chicopee Falls, as mentioned in the discussion of the Springfield-Chicopee Falls via Liberty Street route, will cost approximately	$9,500.00
Double tracking on St. James Avenue between Worthington and Princeton Streets, will cost approximately	17,500.00
Carew Street Extension, between Chestnut and Liberty Streets, will cost approximately	50,000.00
Rebuilding of tracks on Dwight Street will cost approximately	47,500.00

All of the above work, totalling nearly $125,000, should be done at once. It is understood that at this writing material has already been ordered for most of it.

Chestnut Street is now occupied by a single track and the street is too narrow for the construction of double track which is seen to be necessary to accommodate the increasing travel between the Glenwood district and the downtown section. On this account it may soon be necessary to construct double track on North Street from Lyman Street to Jefferson Avenue, to-

gether with a double track on Jefferson Avenue between North Main and Chestnut Streets. It is estimated that this construction will cost approximately $125,000.00.

In connection with the above, it probably at the same time will be necessary to construct a second track and reconstruct the first on Chestnut and Springfield Streets between Jefferson Avenue and the beginning of the double track at Atwater Street. This will cost approximately $23,000.00.

A further extension of the track on Carew Street between Liberty Street and Page Boulevard, as mentioned in the discussion of the St. James Avenue to East Springfield route, will cost approximately $37,000.00.

A further extension of the double track on St. James Avenue, between Thompson and Worthington Streets will cost approximately $8,000.00.

The construction of the second track and reconstruction of first track on Belmont Avenue between Belleview Avenue and Oakland Street will cost approximately $28,500.00.

It is entirely possible that congestion on South Main Street cannot be entirely relieved with the present track facilities and that it will be necessary to provide some additional route for traffic to and from the Forest Park and other outlying districts now using the South Main Street route. Such additional track facilities would either be located on a southern extension of Dwight Street, coming into South Main at about Mill Street, as has been proposed by some, or it might be via Water Street and Pecousic Avenue, connecting with South Main Street at a point somewhere near York Street. As the Dwight Street extension proposition is still somewhat in the air (although it also may later be necessary), the Pecousic Avenue-Water Street extension only has been estimated. To carry this construction as far north as Court Street would cost approximately $170,000.00.

As the location of the new bridge is not definitely known at this writing, it is impossible to make close estimates of the new track construction which will be necessary on that account. It will, however, no doubt be necessary, in order to properly care for the traffic over the new bridge and its approaches in West Springfield, to double track Main Street and New Bridge Street

in West Springfield. Such construction as probably will be necessary on account of the new bridge will cost in the neighborhood of $200,000.00.

The total of the above estimates of track construction, which doubtless will be required in the near future, amounts to about $700,000.00, of which, as stated, at least $125,000 should be expended in the immediate future. These estimates do not include amounts which should be expended for the purchase of new cars and equipment, together with increased facilities for housing and repairs. These items will require expenditures approximating $300,000 in the near if not immediate future.

As discussed later in this report, such additional expenditures can only be made if measures can be taken to increase the net income of the company, so as to make possible a proper return on the investment. Otherwise, it will not be possible to induce the investing public to furnish additional capital.

Springfield Street Railway Company

INCOME STATEMENT for year ending June 30, 1916,
Excluding "Western Massachusetts" estimated figures
Excluding "Springfield & Eastern" estimated figures
Excluding Express Revenue and segregated expenses

Leaving (estimated) PASSENGER (and miscellaneous) INCOME STATEMENT FOR THE SPRINGFIELD CITY DIVISION

OPERATING INCOME:		
Passenger Revenue	$1,816,744.20	
Chartered Car Revenue	4,817.57	
Mail Revenue	2,909.75	
Advertising	8,125.14	
Other Revenue Accounts	22,332.65	
		$1,854,929.31
RAILWAY OPERATING EXPENSES:		
Way and Structures	$130,467.66	
Equipment	216,677.93	
Power	222,426.22	
Conducting Transportation	600,216.07	
Traffic	4,563.72	
General and Miscellaneous	247,012.54	
		1,421,364.14
Net Revenue, Railway Operations		$433,565.17
Taxes assignable to Railway Operations		91,937.37
Operating Income		$341,627.80
DEDUCTIONS:		
Miscellaneous Taxes	$ 523.72	
Interest on Funded Debt	68,000.00	
Interest on Unfunded Debt	46,573.84	
Miscellaneous Debits	287.52	
		115,385.08
NET INCOME		$226,242 72

UNIV. OF CALIFORNIA

THE PAYING HAUL IN SPRINGFIELD

Relation of Length of Ride to Cost of Service

The following discussion on the above subject is confined to the business of the Springfield company which is included in the present central five-cent fare zone, which may be called the Springfield City Division.

The table on the opposite page shows an estimated passenger income statement for the Springfield City Division. The figures shown thereon were obtained by taking the income statement for the entire Springfield Street Railway Company for the year ending June 30, 1916, and deducting therefrom estimates of the part of each income and expense account which applied to the former Western Massachusetts and Springfield & Eastern. Very accurate data was available for these estimates in some of the accounts, such as Passenger Revenue, Cost of Power, Cost of Conducting Transportation, other pay rolls, etc. In the case of some other accounts, such as Maintenance of Equipment which was used partly in the Springfield division and partly outside, it was necessary to pro rate the accounts on a car mile or other suitable basis. It is believed, however, that the statement is a fair estimate of the figures which are directly applicable to the Springfield city division, as above defined. Express and freight revenue and the corresponding segregated operating expenses were also deducted.

Other figures which are used in the following discussion and calculations are as follows:

Load factor—determined from the traffic survey, as shown in the table on page 49,	47%
Average ride per passenger—determined from the traffic survey, as shown in the table on page 49,	2.43. mi.
Number of revenue passengers (including transfer passengers), Springfield city division, year ending June 30, 1916—from company's records,	44,859,662
Number of transfer passengers, Springfield city division, year ending June 30, 1916—from company's records,	7,044,526

Based on the above figures, the length of paying haul has been determined by the use of two methods—first, that developed by the Wisconsin Railroad Commission, and the second, one used by a joint Massachusetts commission consisting of members of the Public Service Commission and the Boston Transit Commission.

The method developed by the Statistical Department of the Wisconsin Railroad Commission in the Milwaukee fare cases involves the determination of the independent variable factors and the separation of total cost into these various components. The total cost of service is separated under two general groups, viz., Terminal and Movement Cost, the various items being as follows:

(a) Expenses which exist even though there is no traffic (Terminal Cost) consisting of:

Expenses which vary with the miles of track operated
Demand expenses at power plant
Depreciation due to causes other than traffic

(b) Expenses proportional to traffic (Terminal or Movement Cost dependent on load factor) consisting of:

Expenses which vary with the car miles run
Expenses which vary with the car hours run
Output expenses at power plant
Depreciation due to traffic
Return on investment

(c) Expenses proportional to number of passengers carried (Movement Cost)

(d) The purely administrative expenses, including taxes, are pro rated to the above groups

The load factor mentioned under heading (b) is the ratio between the total number of passenger-miles and the total number of seat-miles. In other words, it is the relation between service used and service furnished.

On the basis outlined above, the cost of passenger service for the Springfield division for the fiscal year ending June 30, 1916, as shown by the statement on page 100, has been distributed as shown by the statement on page 103.

Distribution of Cost of Passenger Service
Springfield Division, Springfield St. Ry. Co.
Fiscal Year Ending June 30, 1916

(a) Expenses which exist even though there is no traffic (Terminal Cost):		
Approximately 59% of Way & Structures accounts...		$76,609.79
Depreciation of Equipment		30,242.93
Approximately 7% of Power accounts		14,549.98
		$121,402.70
(b) Expenses proportional to car movement (Terminal or Movement Cost, dependent on load factor):		
Approximately 41% of Way & Structures accounts...		$53,857.87
Equipment accounts (except Depreciation).....		186,435.00
Rent of Equipment*		2,572.17
Approximately 93% of Power accounts		207,876.24
Conducting Transportation accounts.....		600,216.07
25% of Injuries and Damages account*		37,470.72
Return on Investment:		
Interest on Debt $114,573.84		
Net Income 226,242.72		
		340,816.56
		$1,429,244.63
(c) Expenses proportional to number of passengers (Movement Cost):		
Traffic accounts		$ 4,563.72
75% of Injuries and Damages account*		112,412.18
66 2-3% Gen. Office, Clerks, Supplies & Exp., Ptg. & Stat'y.*		24,176.38
		$141,152.28
(d) Administrative Expenses:		
General & Miscellaneous accounts, except as above marked*		$70,668.61
Taxes		92,461.09
		$163,129.70
Adding pro rata share of Administrative Expenses:		
A Total expense independent of traffic.....		$133,108.81
B Total expense proportional to car movement....		1,567,057.79
C Total expense proportional to number of passengers		154,762.71
		$1,854,929.31

Distributing item B—total expense proportional to car movement—between Terminal and Movement Cost on the basis of a load factor of 47%, we have the final distribution as follows:

Terminal Cost:	
Expenses independent of traffic	$133,108.81
53% of expense proportional to car movement	830,540.63
Total Terminal Cost	$963,649.44
Movement Cost:	
47% of expense proportional to car movement	$736,517.16
Expense proportional to number of passengers	154,762.71
Total Movement Cost	$891,279.87

Dividing the total Terminal Cost by the number of passengers carried, we have:

$\frac{\$963,649.44}{44,859,662} = \$0.0215$—Terminal Cost per passenger

Multiplying the total number of passengers by the average ride per passenger, we have:

44,859,662 x 2.43 = 109,008,980—passenger miles per year

Dividing the Movement Cost by the number of passenger miles, we have:

$\frac{\$891,279.87}{109,008,980} = \$0.00817$—Movement Cost per passenger mile

Dividing the annual passenger revenue by the total number of passengers, we have:

$\frac{\$1,816,744.20}{44,859,662} = \$0.0405$—Average fare per passenger

Deducting the Terminal Cost per passenger ($0.0215) from the average fare per passenger ($0.0405), we have remaining $0.0190, which is available for the movement of the average passenger. Dividing this amount by the Movement Cost per passenger mile, we have:

$\frac{0.0190}{0.00817} = 2.33$ miles, which on the above basis is the paying haul of the average of the passengers considered, those paying either cash, cash ticket or transfer. As the cash, plus cash

ticket passengers represent 84.3% of all those passengers, we have:

$\frac{2.33}{0.843} = 2.76$ miles as the paying haul for cash or cash ticket passengers, this distance including the ride on transfer if used.

The above determination was, as stated, made with the allowances for return on investment and depreciation as they were actually made in the fiscal year ending June 30, 1916. At the end of that year, there was a total investment in the Springfield division of $5,348,744.86. If there had been an average 7% return on that investment, such return would have amounted to $374,412.14, or an increase of $33,595.58 over the actual, as shown by the statement on page 103.

If an allowance had been made for depreciation on the reasonable basis of a twenty-year composite life of the entire property, calculated on the 3% sinking fund basis, the depreciation allowance would have been 3.72% of the investment as noted above, or $198,973.31, or an increase of $168,730.38.

If a reasonable allowance had been made for contingencies, say, of 1% of the operating revenue, a further amount should have been set aside equalling $20,780.35.

With the above additions, the operating income for the year under consideration should have been as follows:

Operating income (actual) as shown in table on page 100,		$1,854,929.31
Additional required for return on investment, as above,	$33,595.58	
Additional required for depreciation, as above,	168,730.38	
Additional required for contingencies, as above,	20,780.35	
Total additional amount required		$223,106.31
Total operating income required		$2,078,035.62

It should be noted that the above contemplates reasonable return on investment, depreciation allowance and contingency

allowance, based on the present investment only, with no allowance for the additional investment which probably will be required in the near future.

Based on the above, the following calculation of the length of paying haul is made by the same (Wisconsin) method. The additional amounts required are distributed as follows:

	Terminal Cost	Movement Cost
Additional return on investment (53-47%)	$17,805.66	$15,789.92
One-third depreciation asumed to be "independent of traffic".....$66,324.44		
Less amount at present allowed... 30,242.93		
	36,081.51	
Balance of additional depreciation (53-47%)..	70,303.90	62,344.97
Contingency allowance (53-47%).....	11,013.59	9,766.76
Total additions to Terminal Cost.....	$135,204.66	
Total additions to Movement Cost.....		$87,901.65

Making the above additions to the actual Terminal and Movement Costs, as shown on page 104, we have a total Terminal Cost of $1,098,854.10 and a total Movement Cost of $979,181.52. We then have the following:

$\frac{\$1,098,854.10}{44,859,662} = \$0.0245$—Terminal Cost per passenger

$\frac{\$979,181.52}{109,008,980} = \$0.00898$—Movement Cost per passenger-mile

The average fare per passenger, as before determined, is $0.0405. Deducting $0.0245, the Terminal Cost per passenger, we have remaining $0.0160, which is available per passenger for movement. The paying haul is obtained by dividing this amount by the Movement Cost per passenger-mile as follows:

$\frac{0.0160}{0.00898} = 1.78$ miles, which is the paying haul for the average of all passengers including those paying cash, cash tickets and transfers.

As cash, plus cash ticket passengers represent 84.3%, we have

$\frac{1.78}{0.843} = 2.11$ miles, which is the paying haul for cash or cash ticket passengers, this distance including the ride on transfer if used, and with reasonable allowances for return on present investment, depreciation and contingencies.

No allowance has been made in the above calculations for additional capital which probably will be required in the near future for extensions, additional equipment, etc. If it be assumed that $1,000,000 additional capital be put into the property, it may reasonably be assumed that both the number of passengers carried and the number of passenger-miles will be increased by about 5%. Assuming such increases and the same allowances for return on investment and depreciation on the additional capital, as assumed in the last calculation, a third calculation was made with the result that the paying haul was estimated to be the same as under the last calculation, namely, 2.11 miles.

In the following, the paying haul is calculated by a method which was used in estimating the "maximum length of profitable ride" for the Boston Elevated Railway in a report made by the Joint Commission on Investigation of Service of Street Railway Companies, (see Second Annual Report of Massachusetts Public Service Commission, pages 478 to 482, inclusive).

The income statement for the Springfield city division, as shown on page 100, is divided as follows:

The investment received a return of	$ 340,816.56
Other charges are	1,514,112.75
Total	$1,854,929.31

As shown here, the total expenditures are divided as 18.35% as return on investment and 81.65% as other charges.

Dividing the passenger revenue by the number of cash, plus cash ticket passengers (excluding transfers) we have:

$\frac{\$1,816,744.20}{37,815,136} = \$0.048$—Average fare of cash, plus cash ticket passengers

Such average fare received is divided as follows:

Return on investment, 18.35% of 4.8 cents = 0.88 cent

Available for expenses and taxes,

81.65% of 4.8 cents = 3.92 cents

Dividing the total amount expended for operation and taxes by the number of passenger-miles, we have:

$\frac{\$1,514,112.75}{109,008,980} = 1.39$ cents—Cost per passenger-mile, exclusive of return on investment

The paying haul by this method, with the same return on the investment, as in 1916, is therefore:

$$\frac{3.92}{1.39} = 2.82 \text{ miles}$$

If the return on the investment had been 7%, with a depreciation allowance of 3.72% and an allowance of 1% of gross for contingencies, there would have been, as shown on page 105, an increase in the return on the investment, plus depreciation and contingency allowances, of $223,106.31, and the total expenditures would have been:

Return on investment	$ 563,922.87	or 27.15%
Other charges, same as above	1,514,112.75	or 72.85%
Total	$2,078,035.62	

In this case, the division of each fare received would have been as follows:

Return on investment, plus depreciation and contingency allowance, 27.15% of 4.8c = 1.3 cents

Expense for operation and taxes, 72.85% of 4.8c = 3.5 cents

The cost per passenger-mile, exclusive of return on investment, would be the same as calculated above, or 1.39 cents.

The paying haul would have been:

$$\frac{3.5}{1.39} = 2.52 \text{ miles}$$

The paying hauls, as calculated by the two different methods and with the different assumptions as stated, are shown below:

	Wisconsin Method	Mass. Method
With return on investment and allowance for depreciation as in 1916	2.76 mi.	2.82 mi.
With allowances for 7% return on investment, depreciation allowance based on 20-year composite life, and contingency allowance of 1% of gross	2.11 mi.	2.52 mi.

It is believed that the Wisconsin method is the more accurate of the two used, in that it definitely takes into account the load factor, and charges the cost of hauling empty seats as a terminal or "readiness to serve" charge. The Wisconsin method further recognizes that certain definite parts of the operating costs, such as part of the maintenance of way and structures, the standby costs at the power stations, and a part of depreciation, as well as taxes, are also independent of the movement of traffic and are a part of the terminal or readiness to serve charge, which is apportioned equally among all passengers carried.

On the other hand, the Massachusetts method puts only the return on the investment and the depreciation allowance in the readiness to serve charge, which is apportioned equally among all passengers. It will be noted that as the allowances for return on investment and depreciation increase, the discrepancy between the paying hauls, as determined by the two methods, increases.

It is safe to say that the limit of paying passenger haul on the Springfield division is somewhere around 2¾ miles, with the 1916 allowances for return on investment and depreciation. It is also safe to say that with the proper allowances for these items, the paying haul is less than 2½ miles, in all probability being less than 2¼ miles. Any passenger who is carried less than this distance, including the ride on transfer if made, is carried at a profit to the company, while any passenger carried more than this distance for a single fare is carried at a loss to the company.

The table on page 49 shows the average ride for all passengers to be 2.43 miles. This figure must be increased by the relation between cash, plus cash ticket passengers, and the total of those passengers with transfer passengers, which relation is, as has been stated, 84.3%. The average ride of the cash passenger in Springfield, including the ride on transfer when used, is 2.43 miles divided by 0.843, which is 2.88 miles. The difference between this and the 2.76 (or 2.82) miles, as calculated above, is due to passengers now getting the benefit of service provided by the miscellaneous revenue of the company. The difference between the present average ride of 2.88 miles and the paying haul of 2.11 (or 2.52) miles, as shown above, represents the distance over which the average passenger is carried at a loss to the company.

Increased Revenue Needed

As shown by the preceding analysis of operating costs, the Springfield division (the present central five-cent fare zone) of the railway company failed during the fiscal year 1916 by about $225,000 to earn enough to make a proper return on investment, and set aside a proper amount for depreciation and a proper contingency fund. The amount quoted was estimated on the basis of the investment in the territory considered at the end of the 1916 fiscal year. As shown by the table on page 94, approved improvement requisitions, not yet completed, call for the addition of about $750,000 to that investment, and estimates shown on pages 97 to 99, inclusive, of the cost of improvements which will further be required in order to provide satisfactory service call for an additional expenditure of about $1,000,000. These expenditures cannot be made unless some measures are taken to increase the net income of the company. Such increase must come either by an increase in revenue or a decrease in operating expenses.

Some of the recommendations contained in this report look toward a reduction in operating expenses. Such items include, for instance, a reduction in the non-rush hour service on the outer portions of some of the longer routes, a few possible reductions in service during non-rush hour periods throughout the whole length of certain routes, etc. Such reductions as can be made in operating expenses, however, probably will be more than balanced by the present and future increases in costs of labor and materials over prices which were considered normal but a few years ago. That the "increase in cost of living" has affected the railway company, as well as individuals, may be illustrated by citing specific increases in unit prices of a few of the materials which are purchased extensively by the railway company. Such items as are shown do not constitute the entire list, but are taken as typical of the advance in prices which has been a general one through the entire list. Comparing unit prices in March, 1917 with those of 1910, steel car axles have advanced 69%; track bolts, 120%; armature coils, 128%; gears, 104%; steel poles, 139%; steel rail, 30 to 35%; cold rolled steel, 260%; trolley wheels, 78%; trolley wire, 155%.

It is evident, therefore, that in order to provide the necessary additional facilities which apparently are required, or even to pay a reasonable return on the investment at present made and authorized, it will be necessary to increase the revenue in some way.

The increase in business due to the growth of the city and its corresponding greater activity will provide some additional revenue. A proper regulation of the transfer traffic, as is estimated elsewhere in this report, may provide some $30,000 additional revenue. A proper and equitable regulation of the jitney competition possibly may result in a return to the railway company of some of the patronage now diverted to jitney transportation. Reduction of street congestion in the downtown district may permit the operation of additional short route cars, as discussed elsewhere in this report, and this may result further in regaining more of the patronage which is now diverted to jitney transportation.

Such estimates as can be made of the probable effect of these factors on operating revenue seem to indicate plainly that if the large expenditures be made which are necessary to give the city adequate transportation service, a considerable amount of additional revenue must be obtained by some sort of an increase in fares. Such a course has been found necessary by a large number of railways and is being considered seriously even in such large cities as Boston and more recently in Philadelphia. The Springfield company finds itself, in common with many other street railways, the victim of rapidly increasing costs of labor and materials (or if another form of statement be preferred, the decreasing purchasing power of our money units), coupled not only with a fare which has been unchanged for years but with the necessity for furnishing for that same fare an increasing amount of service as average rides increase.

Either some increase in fares must be had or proper allowances cannot be made for depreciation and return on investment. If proper return is not made on investment, new capital cannot be induced to provide the additions and extensions needed. Such a combination of events must result ultimately, whether by the route of a receivership or municipal ownership, in inadequate service until matters are adjusted by some larger

increase in fares or, in the case of municipal ownership, if fares are kept down, the deficit must be made up by the community in some form of taxation. It seems preferable that those who receive the service should pay for it, or in other words, that fares should be adjusted so that the income derived therefrom will pay the total costs incident to the service. However, it remains for the public to determine whether such readjustment of fares be made, or the taxpayers be required to furnish transportation.

The peculiar layout of the Springfield central five-cent fare zone, as compared with the distribution of population, separates a great bulk of short haul riding which is within the central two-mile radius of Court Square from another large class of long haul riders originating in the outlying districts of the Chicopees, Indian Orchard, the Longmeadows, Agawam, Feeding Hills, Mittineague and the northern part of West Springfield. An equitable arrangement should not force short ride patrons residing within the two-mile radius to accept poor service in order to give those in the districts mentioned outside of that radius overly long rides at a loss. A fair method of accomplishing the increase in fare seems, therefore, to involve the placing of the additional burden on the traffic which originates in these outside districts. This might be accomplished by establishing an inner five-cent fare zone with a radius of about two miles from Court Square and making an additional charge of two or three cents to riders beyond that zone, with the transfer privilege only slightly modified from the present. A second plan might provide a five-cent ride with free transfer between any two points within the central two-mile radius zone and a five-cent fare without transfer between the downtown district and the outlying limits of the present five-cent fare zone. Modifications of these plans may suggest themselves on further study.

At this time, a sufficient analysis of costs on the various routes has not been made to enable definite and detailed recommendations to follow. It is only desired to point out the fact that in some way an increased fare must be received in order to enable the railway company to serve the community properly. The above are mentioned as suggestions as to what might

be developed by an intelligent, detailed study of the problem. Data which is at hand as a result of the traffic survey, if combined with fairly definite apportionments of investment and operating expense as between the various lines, will allow points to be definitely established which should be the limit of the central five-cent fare zone. Data which is at hand as a result of the traffic survey also will enable close estimates to be made of the amount of increased revenue which might be expected as a result of any change such as those suggested above.

A zone system of fare collection such as one of those suggested above will involve a number of difficulties in the proper collection of fares and use of transfers, including the development of some system whereby different fares can be collected from different passengers travelling over portions of the same route, in some cases in the same car, and the proper designation of such passengers so that evasion of proper fares may be eliminated. Such difficulties will be much greater in the rush hours than during the normal periods of the day. It is not impossible to develop a system of fare collection and transfers which would reduce such difficulties to a minimum. However, such a development may require some considerable time for its accomplishment, and in view of the apparent necessity for some immediate relief, it may be deemed advisable to obtain it by a flat increase to a universal six-cent fare, such as is proposed in similar cases in Boston and in Philadelphia. Such six-cent fare might later be replaced by a zone system after detailed studies, as recommended herein, have been completed.

ADDENDA

To Report Dated April 30, 1917

Traffic and Operation

Springfield Street Railway Company

PREMIUMS ON CAPITAL STOCK

The amount of $5,348,744.86, shown on page 105 as the investment in the Springfield division, does not include the amount of $604,575.11 which at various times has been paid in as premiums on the capital stock and invested in the property under the provisions of the Massachusetts statutes. That amount was omitted in the calculations shown on pages 105 and following, as it is not being carried in the company's balance sheet. However, it undoubtedly would be considered in any judicial determination of the cost of the company's property. The amount mentioned has been invested as follows:

Track construction	$210,000.00
Overhead line construction	40,000.00
Rolling stock	259,575.11
Power station	95,000.00
	$604,575.11

INCREASED COST OF OPERATION DURING LAST HALF OF 1916

Since the report went to press, operating data for the calendar year ending December 31, 1916, has become available. The general statistical data and various operating details, for which a comparison of six years is shown on pages 12 to 28, inclusive, include figures only up to and including the fiscal year ending June 30, 1916. The discussion on the paying haul and necessity for increased revenue are based on data applying to the fiscal year ending June 30, 1916.

The following tables compare various items of expenditures and other operating statistics for the entire system, as between the fiscal year ending June 30, 1916, and the calendar year ending December 31, 1916, thus showing the effects of the operation of the last six months of 1916.

It will be noted that although the operating revenue increased 5%, the operating expense increased 10.7%, so that the ratio of expense to revenue increased from 76.5% to 80.6%. Comparing the various items of operating expense, it will be noted that maintenance of way and structures, power, and the expense of conducting transportation (except wages of conductors and motormen) increased slightly, while there were decreases in the percentages expended for maintenance of equipment and general and miscellaneous expense. There was an increase of 15% in the amount expended for wages of conductors and motormen, this item amounting to 27% of the total expenditures in the year ending June 30, 1916, and increasing to 29.2% in the year ending December 31, 1916. The item of taxes increased about 13%. The return on investment decreased about 12%, and the deficit was increased from $28,543 to $65,309.

DISTRIBUTION OF EXPENDITURES
SPRINGFIELD STREET RAILWAY COMPANY

	Fiscal Years Ending June 30, 1916		Fiscal Years Ending December 31, 1916	
	Amount	P. C.	Amount	P. C.
Maintenance, Way and Structures	$165,407.61	7.2	$206,115.41	8.4
Maintenance Equipment	255,595.47	11.1	242,381.15	9.8
Power	283,349.89	12.2	318,688.67	12.9
Wages of Conductors and Motormen	625,419.55	27.0	719,428.45	29.2
Balance of Conducting Transportation	123,332.64	5.3	140,145.10	5.6
General and Miscellaneous, including Traffic	294,988.17	12.7	308,122.31	12.5
Total Operating Expenses	$1,748,093.33	75.5	$1,934,881.09	78.4
Taxes (Railway)	123,549.63	5.3	139,735.70	5.7
Miscellaneous Taxes and Debits	811.24	.03	717.48	.03
Return on Investment (Interest and Dividends)	443,576.70	19.2	391,928.90	15.9
Total Expenditures	$2,316,030.90	100.0	$2,467,263.17	100.0
Railway Operating Revenue	$2,284,918.38	98.7	$2,399,698.61	97.3
Non-operating Income	2,569.11	.1	2,255.16	.1
Deficit	28,543.41	1.2	65,309.40	2.6
	$2,316,030.90	100.0	$2,467,263.17	100.0

OPERATING STATISTICS

	Fiscal Year Ending June 30, 1916	Dec. 31, 1916	Per cent Increase (+) or Decrease (—)
Operating Revenue	$2,284,918	$2,399,699	+ 5.0
Operating Expense	$1,748,093	$1,934,881	+ 10.7
Wages of Conductors and Motormen	$ 625,420	$ 719,428	+ 15.0
Interest and Dividends	$ 443,577	$ 391,929	— 11.6
Revenue Car Hours	877,138	958,845	+ 9.3
Revenue Car Miles	8,307,431	8,828,997	+ 6.3
Per Cent Revenue in Operation	76.5%	80.6%	+ 5.4
Per Cent Revenue in Wages Conductors and Motormen	27.4%	30.0%	+ 9.5
Per Cent Revenue in Interest and Dividends	19.4%	16.3%	— 16.0
Revenue per Car Mile	27.5c.	27.2c.	— 1.1
Operating Expense per Car Mile	21.1c.	21.9c.	+ 3.8
Wages Conductors and Motormen per Car Mile	7.5c.	8.2c.	+ 9.3
Interest and Dividends per Car Mile	5.3c.	4.4c.	— 17.0
Car Miles per Car Hour	9.48	9.2	— 2.9

INCREASED REVENUE REQUIRED

A calculation, similar to that shown on page 105 of the report, but based on the operation of the *calendar year 1916*, for the *whole system* of the Springfield Street Railway Company, follows:

Investment (excluding premiums on capital stock not shown on balance sheet, amounting to $604,575.11)		$8,098,872.68
Operating Expenses, 1916		$1,934,881.09
Taxes (Railway)		139,735.70
Depreciation, based on 20-year composite life of property, calculated on 3% sinking fund basis,		
3.72% of investment	$301,278.06	
Less amount actually allowed	37,668.24	
		263,609.82
Return on investment, 7%		566,921.09
Contingency allowance, 1% of gross		29,344.93
With such allowances, gross receipts should have been		$2,934,492.63
Actual gross receipts		2,401,953.77
Additional revenue required (22% increase)		$532,538.86

ALBERT S. RICHEY
WORCESTER, MASSACHUSETTS
MAY 19, 1917

YC 91388

464985

HE4491
S825S8

UNIVERSITY OF CALIFORNIA LIBRARY